Radio, Electronics and Communications

FORMERLY "RADIO & ELECTRICAL REVIEW" — WIDELY KNOWN SINCE 1946 AS "R. & E."

In This Issue . . .

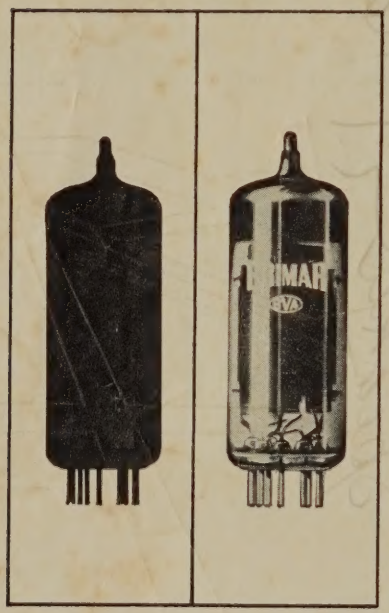
- Selecting a mini-computer
- Data Transmission — Part 1
- Colour TV — Part 4
- Strays
- New Products & People
- N.Z.B.C. collection old radios

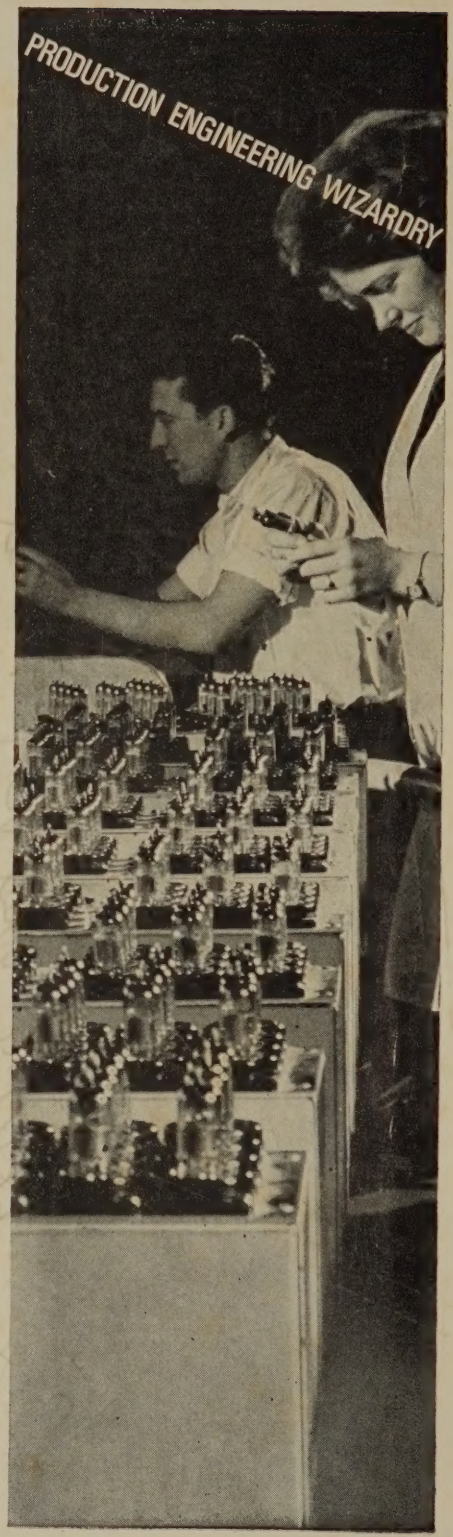
PUBLISHED MONTHLY IN THE INTERESTS OF THE N.Z. ELECTRONICS INDUSTRY FOR ALL LEVELS, FROM PROFESSIONAL TO AMATEUR.

VOLUME 25 NUMBER 8

NOVEMBER 1, 1970 PRICE 25c

Brimar puts life into new valves





BRIMAR

When Brimar valves are assembled, heated, pumped to the highest degree of vacuum and finally sealed in their glass envelopes, they are complete—but the spark of life is yet missing.

On a machine as ingenious and as bizarre as any from the world of science fiction, the valves are arranged in banks on a series of moving platforms. At each stop on their journey around a huge revolving table, arrays of light bulbs glow and flash as varying voltages are automatically applied for varying lengths of time to grids, cathodes and anodes. This removes the last residual traces of gas from the electrodes and brings every working surface up to optimum working condition.

But the valve that springs to life is very much of this world – a component of a precision and consistency of quality that only Brimar's brand of production engineering ingenuity can produce.

Standard Telephones and Cables (New Zealand) Limited

Box 10097, Auckland, Box 40140, Upper Hutt,

Now your calculator can control your instruments.

You don't have to hand feed data to your calculator any more. Nor control instrument tests conditions. Our new HP 2570A Coupler/Controller gives you an inexpensive way to transfer data, automatically, from your instruments to your HP 9100 Calculator. It lets the calculator control your instruments and test stimuli. And record results on a teletypewriter or high-speed punch, as well as the calculator printer and plotter.

There's no programming language to learn—just use the calculator keyboard. Program all instrument functions simply by hitting the "format" key. You get the problem solving conditional programming and system control capabilities of a computer—without computer cost.

Price of this 2570A is only $1625. Interfaces cost $450-$1500 per device. Now your calculator can be the base of a simple, real-time data acquisition and automatic test system. If you don't own an HP calculator all the more reason to get one. For some revealing cost comparisons, contact Hewlett Packard (N.Z.) Ltd. Also: 9100 Interface to IBM 735 Typewriter — $1,000.

Contact Hewlett-Packard (N.Z.) Ltd.

HEWLETT hp PACKARD

WELLINGTON: 32-34 KENT TCE., P.O. BOX 9443; PHONE 59-559
AUCKLAND: P.O. BOX 51-092; PHONE 573-733

ENQUIRY A45. USE FORM AT REAR

Radio, Electronics and Communications

Formerly Radio and Electrical Review
(Established 1946)
OFFICIAL JOURNAL OF
The New Zealand Electronics Institute (Inc.)

CONSULTANT EDITORS:
C. W. Salmon, C.Eng., A.M.I.E.R.E., A.M.I.E.E., M.N.Z.I.E.
representing the National Electronics Research Council (N.Z.)
P. L. Watts

EXECUTIVE EDITOR:
Robin H. E. Beckett.

WELLINGTON CORRESPONDENT:
B. S. Furby.

* * *

Published Monthly by the Proprietors:
THE MAGAZINE PRESS LTD.,
Publishers also of
HOME AND BUILDING
at the Registered office of the company, Employers Association Building, 157 Khyber Pass, Auckland, 3, N.Z. P.O. Box 1365, Auckland. Telephone 362-957 (2 lines).

Director and Chairman:
Victor L. Beckett A.A.I.(Aust.) Hon.A.N.Z.I.A.

Director and Secretary:
Wilma W. Beckett

Production Manager:
Robin H. E. Beckett, B.A.

• • •

Sole New Zealand Distributors:
GORDON & GOTCH (N.Z.) LTD.

From Newsagents — 25c per copy. Or direct from the publishers $3 per year in advance, post free throughout the world.

• • •

Advertising Representatives for the United Kingdom.
PUBLISHING & DISTRIBUTING CO., LTD.,
177 Regent St., London, W.1.

• • •

Printed by Farrell Printing Ltd., Mt. Roskill, Auckland. Registered as a newspaper at the G.P.O., Wellington.

November 1, 1970 Volume 25, Number 8

☆

CONTENTS

★

		Page
The Age of Communicators	by Sir Lionel Hooke	13
Selecting a mini-computer	by G. L. Kilgore	15
Deflection and convergence systems for the shadow mask picture tube	by P. Cooper	17
Data Transmission — 1	by D. J. Barnes, G. A. Macferson and J. M. Tricker	20
Strays	by the Collector	22
People — profile		23
Down Memory Lane	by B. S. Furby	25
IEEE celebrates its centenary		27
NZEI — Wellington Branch News		27
Packset order		29
Random Noise Generator		29
Departments		
Letters		11
New Products		32

ON OUR COVER

AWA — ELECTRONICS

The front cover typifies AWA's involvement in the supply of navigational aids for aircraft. New Zealand's network of navigational aids could very well be the envy of many countries. AWA has played a part in the supply of ground based navigational aids. The Company has also been a supplier of Doppler navigational equipment to Air New Zealand and automatic direction finders to the R.N.Z.A.F.

On the ground, survelliance radar monitors the movement of aircraft within a radius of 100 miles or more. In the air, VOR provides the pilot with azimuth information; whilst DME gives him his distance from the station. VOR and DME co-ordinates enable the pilot to locate his precise position on a map. An Instrument Landing System comprising locator beacon, the glide-path element and markers, radiate signals which enable the pilot, from a cross pointer indicator on his instrument panel to make a runway approach under conditions of poor visibility.

AWA also performs an important role in the supply and maintenance of radar and navigational aids for ships.

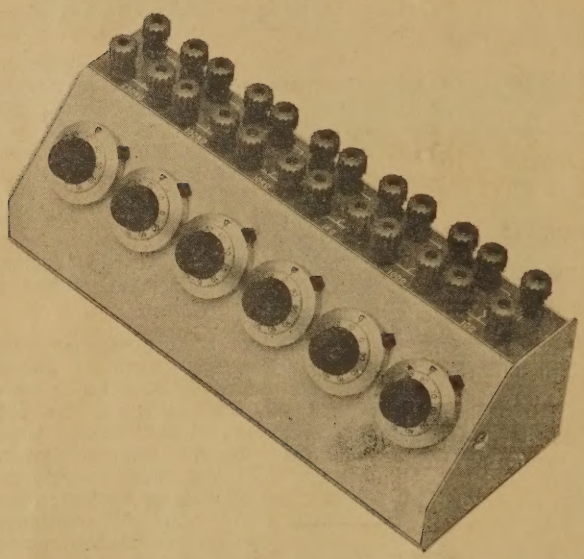
Coming

- Microwave energy — an outline
- Radio Communication in the Ministry of Works
- Design of an electronic supervisory and telemetry system
- A small fast microprogram computer
- An IC data logger for meteorology

Also

- Development of a packset
- Data Transmission — 2
- Audio preamplifier
- Design concepts of DVM's
- SSB for New Zealand

Ten–Turn Precision !



Five decade (plus ¼ Megohm) potentiometer box gives precision resistance values. Ten-turn Duncan potentiometers each with vernier scale have 10 ohm, 100 ohm, 1 Kilohm, 100 Kilohm and 250 Kilohm ranges.

Other models available, or by order to specification.

Terminals provide electrical access to input and output of each potentiometer, or allow various interconnections. These are screw-type terminals which accept bared leads, ¾" double connector links or banana pin connectors. Schematic of internal wiring engraved among terminals to indicate wiring key. Sloping panel for easy visibility and operation.

These are precision resistance boxes for laboratories or senior classes under instruction.

The Cool One

That keeps corrosion out of the cold

-Only Electrolube* Aerosol Freezer

Only Electrolube's* aerosol freezer does more than jet out a chilling, freezing spray: Electrolube* aerosol freezer spreads an electrically-neutral protective film that inhibits corrosion from destructive ice condensate. Safe — on sensitive electronic components—Electrolube* freezer is the fully effective freezer with built-in protection.

Track intermittents, instability or drift when these are thermally responsive.

Protect heat sensitive semi-conductors or pickup cartridges by pre-cooling before soldering.

Check thermometers or thermal cutouts.

Fit over-size components into tight spots. Exploit all the advantages of the aerosol freezing techniques without corrosion or tarnish dangers only with Electrolube*. Price: $1.20 & tax.

Stocks of Electrolube Freezer readily available. SG4 Silicon grease in aerosol tins in stock. PCL (Printed Circuit Lacquer) in aerosols also stocked. PCL ideal in thermal, corrosive or humid atmospheres for circuit protection.

*Electrolube is a registered trademark E1

Available from:

P.H. ROTHSCHILD & CO. LTD.

P.O. Box 30-170 LOWER HUTT 83 Pretoria Street

Telephone: 63-581 Telegrams: "FRANDS"

ENQUIRY A146. USE FORM AT REAR

Laboratory Instuments For Sale

Here is your chance to buy top quality used Laboratory equipment which has only had limited use under our own control and carries the usual twelve months warranty.

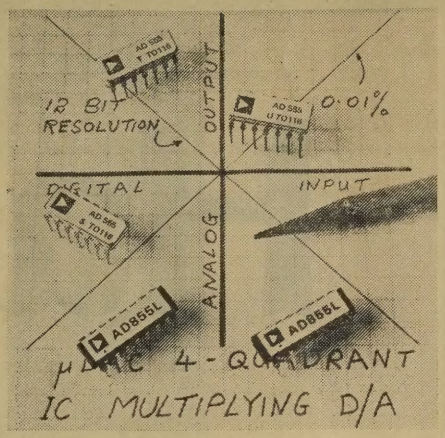
These units are being replaced by our own product lines, and prices apply to these instruments only on a first come basis, subject to prior sale. You are welcome to borrow any instrument for evaluation.

Voltmeters	
AC Millivoltmeter *hp* 400D	200.00
Keithley 155 1 Microvolt FS DC	400.00
Digital Fairchild 7050 DC/Ω	440.00
AC DC Differential Voltmeter Std 741A	850.00
Voltage Sources	
Cal. System AC DC *hp* KD2	562.00
Recorder	
6 Channel High Speed UV Recorder (Galvos Extra)	1075.00
Pulse Generators	
Datapulse 101 10 Hz-10 MHz	450.00
Datapulse 106 10 Hz-10 MHz	500.00
Oscillators	
HF 10 MHz — 420 MHz *hp* 608D	990.00
10 Hz — 10 MHz *hp* 651A	350.00
Function Generator *hp* 3300A with Trigger Phase Lock	500.00
Oscilloscope	
50 MHz Dual Trace Delayed Sweep *hp* Model 175A with Plug-ins	1100.00
Dumont Model 1050	2500.00
Counters	
12.5 MHz Systron Donner 114	500.00
30 MHz Sample Electronics 1030	700.00
500 MHz Systron Donner 1037 with Super High Stab. Osc.	3000.00
VLF Frequency Std. Receiver	1000.00
Converter .2-3 GHz (5245L)	350.00
Transfer Oscillator 12.4 GHz *hp* 540	400.00
R.L.C.	
Impedance Bridge .1% ESI Model 292	950.00
pH Meters	
Vane 203 0-14 ph	95.00
Vane 205 0-8, 6-14 ph	135.00

SAMPLE ELECTRONICS (N.Z.) LTD.

8 Matipo St., Onehunga; P.O. Box 13-256, Auckland 6, New Zealand
Telegraphic & Cable Address: 'ELPMAS,' Auckland. Phone 667-356.

ENQUIRY A223. USE FORM AT REAR



SOPHISTICATED COMPONENTS

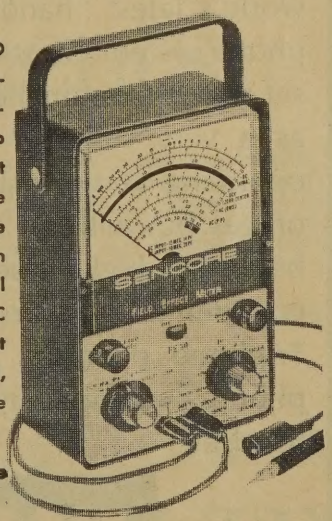
Unique range of Analog Devices — best in the world in its field.

ANALOG DEVICES

O/P Amps — Discrete IC and HYBRID
Function Modules
Instrumentation Amplifiers
Logarithmic Amplifiers
Active Filters
Analog Comparators
BiPolar — Input O/P Amps
FET — Input O/P Amps
Analog/Digital Converters
Digital/Analog Converters

Sole N.Z. Agents — Data and Prices on request.

SOPHISTICATED TEST EQUIPMENT



the fantastic FE14 FIELD EFFECT VOLT-OHM-MILLIAMETER. • Less Circuit Loading than a VTVM; • Zero warm-up time — instant stability; • No bothersome AC cords; • Use it anywhere — any time; • Full protection on both meter and internal circuits — over 100 times AC overload per scale. A Must for Solid State servicing, $89.50. 39A19 Hi Voltage Probe available, $9.95.

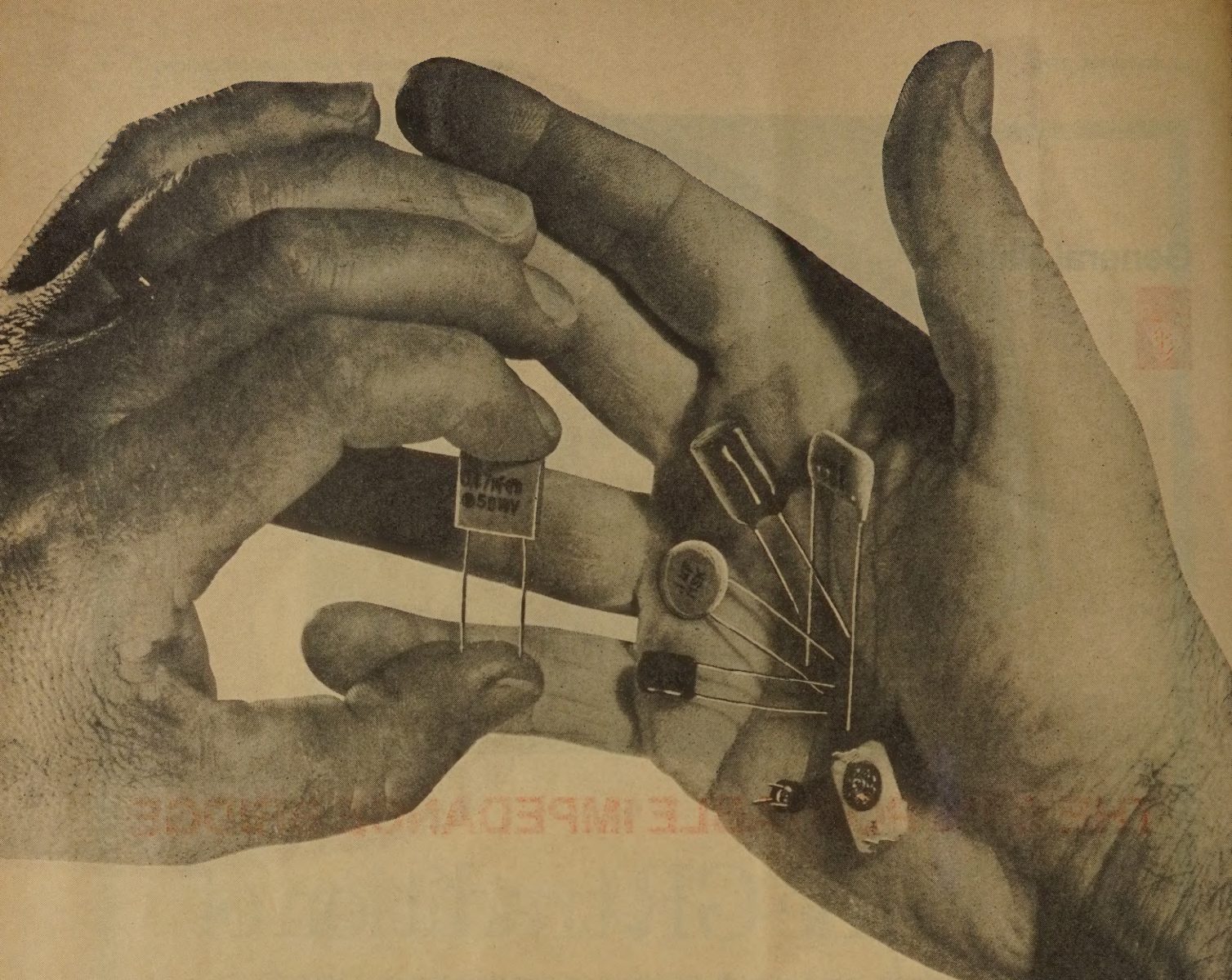
Available ex stock — Sole N.Z. Agents

DAVID J. REID (NZ) LTD.

ELECTRONIC COMPONENT SPECIALISTS

Box 2630, Auckland. 3-5 Auburn St., Takapuna.
Box 2453, Wellington. 12-14 Haining St.
Box 2127, Christchurch. 303 Durham St.

ENQUIRY A217. USE FORM AT REAR



MINI CAPACITORS DEMANDED BY MODERN ELECTRONICS

FAIT ACCOMPLI. These are the small ones with the big capacitance. And more. Much more because they are flat, compact and have upright leads ideal for transistor circuit applications.

They are perfect for most applications because they are physically small for their big capacitance.

Ask about our PML Metallized Lacquer Film Capacitors which are so ideal for filter, blocking, by-pass and R.C. differentiating and integrating applications due to their outstanding non-polar, non-inductive characteristics. In fact, ask us about all of our capacitors — we are capacitor specialists.

Sensibly priced too — consider value for dollar — top performance, quality and reliability — built into your product. Contact us now — we are waiting to be of service.

142 Stoddard Rd.,
Mt. Roskill,
Auckland, 3.
an associate of
HAWKER SIDDELEY ELECTRONICS LIMITED
Australia.

TELEPHONE 695·476

Channel Master (N.Z.) Ltd

This statement from the Chairman of A.W.A. comments on the power and scope of modern communications — and against this background we feel readers will be interested in the role which has been played by one of the oldest firms in electronics in this part of the world. We publish this statement in recognition of the activities of A.W.A. and its notable firsts on the Australasian scene.

The Age of the Communicators

By Sir Lionel Hooke*

This is the age of the communicators. Never before have the techniques of communication enabled those who use them to become so pervasive and vital an element in the world scene.

The ability to communicate, instantly and clearly, both audibly and visually, not merely with a small community audience but with the population of a state or country, or with practically all peoples in the world offers extraordinary avenues for persuasion and influence.

These opportunities obviously pose heavy responsibilities for the communicators who employ them.

Designers and engineers who develop these modern systems do not impose any sanctions on their use.

The responsibility for the use of these extensions of human communications must always be with the communicators themselves.

Those who make the facilities are aware, of course, that on occasion the fate of nations may depend on the reliability of the communications. They know that in lesser matters, such as the vast and complex operations of modern commerce, fortunes depend on the efficiency of the world network of communications; that educators and entertainers can now command immense audiences.

Therefore, makers of electronic equipment seek always to make these means of communication as perfect as is humanly possible.

Improvement is continuous. The speed and efficiency of today's communications would have seemed incredible a few decades ago. The facilities range from such a small but useful service as the radio telephone in local taxicabs to the reception of radio and visual messages from space probes to the moon and the planets.

Practically every facility now available for the communicators has electronic associations — even the long-established postal services and the newspapers and other printed material. The list embraces telegraphs, cables and telephones, radio and television (local, and global), telex, data transmission and computer links. A world-wide network providing encyclopaedic information for anyone on demand is mooted.

International happenings and the reactions of world leaders can be seen and heard immediately. The impact of this is now significantly increasing. The whole expanding field of human knowledge and culture is becoming available everywhere, in all spheres of learning from pre-school to post-graduate.

Australians, as the Postmaster-General, Mr Hulme, said recently, have been more communications-conscious than most other nations because of our one-time isolation in the world, our vast area and our comparatively small population.

Today, communications make us in the most literal sense near neighbours of all other peoples in the world, able to see and talk across the world as readily as across the garden fence to the next door neighbour.

There are doubtless more marvels ahead in the field of communications. Technological progress will continue and it is to be hoped that all these new developments will be applied to the further benefit of mankind.

In Australia, the last 60 years has seen most of the major developments in communications.

A.W.A.'s association with communications goes back to the inauguration of the Company in 1913 when it commenced the installation and operation of wireless equipment in Australian and New Zealand ships and the training of wireless operators.

From this, it turned to experiments in communications and, in 1918 was rewarded when the first direct wireless message from England to Australia was received. In succeeding years, Company activities in wireless included establishment of the Beam service between Australia and Great Britain, telephone service to Great Britain, Europe and America, Beam picturegrams, coastal radio, mobile and aeronautical communication services.

Radio and television are other spheres of communication which A.W.A. pioneered in Australia. The Company's first public demonstration of broadcasting was given in 1919, followed by Australia's first complete public broadcast concert in Melbourne in 1920, a few months after Britain's first advertised programme of public broadcast entertainment.

Seven years before television was introduced in Australia in 1956, A.W.A. gave closed-circuit demonstrations in Sydney and in Melbourne. From these small beginnings, broadcasting has grown to 72 national and 114 commercial stations and television to 41 national and 45 commercial stations.

In another major communications field — telephones — A.W.A. was the first Australian Company to go into production. In the 1930's, it produced Australia's first plastic encased table telephone. From a production of about 100 a week, the Company's present weekly output has risen to about 7,000 instruments of various types.

In co-operation with the Australian Post Office, A.W.A. recently designed a new coloured wall telephone which will become available to subscribers early in 1971. It is also currently supplying the A.P.O. with a new type push-button intercommunication telephone system.

The Company hopes to play a significant part in the development of the television-telephone which is likely to be used here in the next 10 years.

In the more dramatic field of space communication, facilities operated by A.W.A. engineers and technical staff at Carnarvon (W.A.) tracking station were used to maintain voice communication with the lunar astronauts and earlier space flight missions and the transmission of vital data.

*Chairman of Amalgamated Wireless (Australasia) Ltd.

SELECTING A MINI-COMPUTER

By G. L. Kilgore*

Hard wired logic, with its modest initial cost, is the most economical buy for relatively small control systems and for those which are not subject to change, Figure 1. Computers, on the other hand, have proved economical in more complex systems which control many different functions and in systems with a high probability of change. If expansion is anticipated, the computer offers the best control solution. As the price per computation has dropped with each successive generation of computers, more control builders and users have turned to digital computers because of their flexibility and capability. Standardization of digital computer equipment reduces the cost of circuitry, and the flexibility of programming permits control of a number of functions with the same hardware.

Choosing a Mini

Mini computers enroach further into the domain of hard-wired logic systems because they combine a substantially lower initial cost with all the accepted advantages of computer control. They are now proving competitive with wired logic systems in applications such as machine tool control, data terminals, materials handling systems, many automated production facilities, and other smaller tasks.

The choice of units is a broad one. Minicomputers range in price from $5000 to $25,000 for a basic main frame with a teletypewriter.

At the low end of the price scale are a number of special purpose computers, and some machines with a very small word and memory size. From the middle to the upper end of the scale are some sophisticated machines which hold their own very well in almost any process control application. Many of these units have optical features that stretch their capabilities beyond the normally accepted range of minicomputers and some are readily expandable into systems that rival the older big systems.

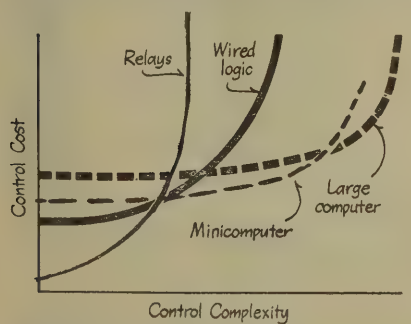


Fig. 1
Plots show how the relative costs of four major control methods vary with increasing application complexity. Minis offer the flexibility of a computer with the relatively low cost of wired logic systems.

The potential customer must decide for himself which of the many units best solves his control problem. That choice requires the evaluation of many factors: the vendor's experience, main frame design, inter-face design, availability of software and engineering support, etc.

Vendor's Background

In the early years of industrial use of computers, the requirement was frequently only for data logging and alarming with, perhaps, some information processing and mathematical calculation which was usually done off-line. During that period, many data processing machines were installed and many of them were called process control computers because they provided the information from which control decisions could be made.

Since then, the picture has changed. A sophisticated computer system in a steel mill, for example, can generate more data in a few hours than a staff of experts can evaluate in days. And if a data logging approach has been taken in system design, nothing gets improved or changed in the mill operation until the evaluation is complete. Therefore, it has become increasingly necessary to permit the computer to make its own evaluation of the reams of data and change the control directly to obtain more desirable results.

The computer company's system capability, then, became one basis for evaluating its machine. If the company is populated primarily with data processing and data logging people, its machine will probably be structured for that type of operation. If the company and its people are experienced in process control, the machine will probably be structured for that duty. This difference will be reflected in both design of the machine and in the capability of the manufacturer to help analyze the application.

The potential computer buyer should also consider what help he will need in putting this black box to work after it is delivered. A first-time computer user can expect to invest four to six months per man in the education of programmers and engineers in the general concepts. If there is a later switch of computer vendors, only two or three months will be required to retrain personnel. These numbers assume that adequate documentation and training schools are provided by the computer vendor. If the computer vendor provides consulting help for the user, this training can be accomplished during the initial system design phase. If no consulting assistance is available, the initial training must wait until the computer is delivered and all documentation is complete.

Main Frame Architecture

Selection of a minicomputer as the heart of an automation system should be on the basis of dollars, delivery, and compatibility between the architecture of the computer and the demands of the application. Primary consideration, of course, must be given to the application.

The arithmetic or logical manipulations required by the control algorithm dictate the capabilities required of the computer. The equations, logical operations, and the number of times they must be repeated will determine the size of the word, the structure of the word, and the memory cycle-time required. Word length may be 8, 12, or 16 bits long, Figure 2. Word length and the availability of double word-length instructions will control the accuracy and speed of computations. Two 8-bit memory words are required to contain the equivalent of one 16-bit word. The 16-bit, 4000 word memory holds twice as many 16-bit numbers as an 8-bit, 4000-word memory. Double word length instructions permit the handling of numbers of twice the word length in a single instruction.

Not all minicomputers have 16-bit core words and not all have double word add and subtract routines. In some minis, this accuracy must be accomplished by subroutines which are much slower than the machine instructions. Before buying those machines, it is necessary to evaluate the effect this decrease in speed of computation will have on the process to be controlled.

Word size also affects the addressing capability of the machine. With fewer bits, the instructions in some machines must be pieced together from two or more words in core memory. In other words, two memory cycles will be required to execute each instruction in this format, and the time required for execution will naturally be longer.

Another difference among minicomputers is the power of the so-called "scratch-and" memory — extra flip-flop registers outside the main body of core memory. Execution of instructions to or from these registers is usually faster than from magnetic core. In some of the small computers, use of these registers is limited to certain instructions; not all instructions will address all locations in memory. Therefore, several instructions may be required to load these flip-flop registers before the computational instructions may be executed. In

First published in "Automation"

*Hagan Computer Systems Div., Westinghouse Electric Corporation.

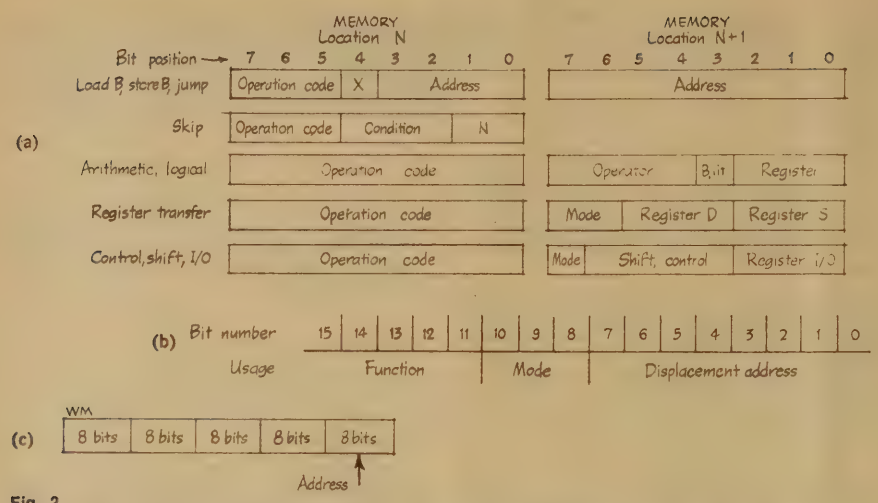


Fig. 2
Minicomputers vary in the word lengths that can be stored in their memories. Word length capability is one of the factors directly related to machine accuracy and speed. Shown here are sample instruction formats for 8 bit (a), 16 bit (b), and byte variable (c) word length capabilities.

this case, program execution may take far longer than the time required for the actual arithmetic operation.

Most computers — in architecture, instruction, repertoire, and addressing capability — have been designed to cope with a particular type of problem or application. Machines with extensive arithmetic capabilities are good for applications where mathematical equations are used. Byte (8 bit) addressable machines are good for communications switching applications. There are also machines which are more easily programmable in Fortran because of their repretoire of instructions. All of these variations should be explored in as much depth as possible before the final selection is made.

Interface Equipment

The black box which you buy from the computer vendor may be only a main frame or it may include enough hardware to wire it directly to your system. In any case, the main frame must somehow communicate with the equipment to be controlled, Figure 3. The signals available at the surface of the main frame are only data lines, address lines, and traffic control pulse lines to indicate when data is available. These signals are at the logic energy level and must be decoded, amplified, and isolated before they can be connected to high-powered equipment in a plant environment. The logic which decodes the address data and switches the data to the proper devices at the proper time is called the input/output (1/0) interface. Advertised computer prices rarely include any of this essential 1/0 equipment. In fact, some computer vendors have no I/O equipment to sell.

Every process control system must have some device such as a keyboard/printer to permit the programmer to talk with the machine. Even then, however, there is still no communication with the rest of the world. Relay drivers and contact readers, analog signal readers and generators, tape readers and punches, card readers and punches, plotters, line printers, dataphone modems, etc., should also be available to establish communication with the process.

Availability of devices and the cost of each varies from computer to computer. Some devices will be needed while creating the computer system, but will not be needed once the system is in operation. The user must now choose whether to buy the devices with the computer system or buy them separately to build his own interface.

When I/O equipment is bought from the computer vendor, it is important to know the signal level requirements and the structure of the I/O package. Most vendors offer dry contact digital I/O equipment which plugs into the computer in modular fashion. The capacity of the contacts and the voltage levels supplied vary from one vendor to another. Analog signal multiplexing and conversion equipment is also usually available for input sensors. The speeds and signal levels will vary greatly. Peripheral devices — such as line printers, tape readers and punches, card readers and punches, disc packs, etc. — are also available with interface packages from most vendors.

In buying the vendor's I/O, it is advisable to buy his executive monitor program which will provide most of the basic programs for input/output operations. These programs provide easy access to all the I/O equipment purchased. Diagnostic programs should also be provided for the I/O devices.

If the user prefers to build his own interface, he must acquire equipment which is electrically and logically compatible with the computer he purchased. The I/O interface is directly related to the structure of the computer. Some machines require every I/O operation to pass the data to or from the accumulator. Others have direct memory access capability. Some machines put data into memory between instructions, others between instruction subsequences. The speed requirements of the peripheral devices will dictate which method is best.

The biggest problem in building the interface is isolation of the computer from the electrical environment. Noise has been the big problem in computer applications since the earliest installations.

The problem is particularly severe with the fast, integrated circuit devices used in computer main frames. Great care must be taken to prevent noise or excessive voltages from entering the circuitry.

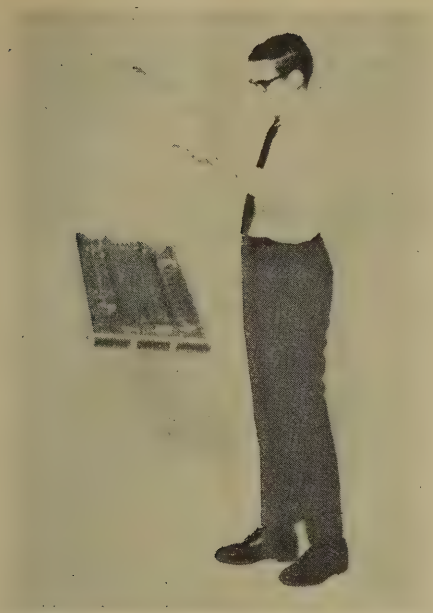
Another, less obvious, pitfall is the assumption that any good circuit designer can cope with the exotic circuitry being put together in computers today. Highly sophisticated MOS devices are common. TTL and 930 series components are used extensively. A designer with no experience with these devices will need some help. In general, interface design should be undertaken by the user only if repeat volume on similar systems justifies the development cost or if the requirements of the process cannot be justified by the vendor's catalog of equipment. This development is costly and difficult.

Support Software

Programming costs are of major importance in implementing a system with a minicomputer. If several hundred computer-based systems are involved, assembly language programming should be considered to make the most efficient use of memory. In this case, concern should be given to the power of each instruction available compared with the requirements of the application. The instruction set should have all the manipulative power needed for logic and arithmetic operations.

Support software — such as assemblers, real-time executives, etc. — will also be needed. Many computer applications have overrun cost estimates because programming support was inadequate. These programs are necessary to reduce costs and schedules. Most vendors offer assembler programs — usually run on the minimum configuration (4K memory) with a keyboard/printer device. Some are single pass programs, which give output directly

Four Boards Equal One Computer with 16K Memory.



Shock Mounting Protects Circuit Board Computers.

from the source. Others are two pass programs, requiring that the source be read into the computer twice to get the results. Some vendors also offer assemblers which are written in Fortran and can be run on large data-processing computers.

If the need is for only a single computer to control a particular function in the plant, the ease of programming that function is of major importance. Therefore, higher level languages are necessary. Fortran has proved to be a good language for process control because it is easy to learn and basic enough to be fairly efficient. However, there are nearly as many versions of Fortran as there are computers on the market. The American Standards Association has defined two levels of the language: Basic Fortran is the lowest level and is the one provided by most minicomputer vendors. ASA Fortran is equivalent to Fortran IV and is a higher-level language.

On-Line Availability

Availability is the sum of reliability and maintainability. The packing, circuitry, and logic modules vary between minicomputers just as much as the architecture. In addition to looking at mean-time-between-failures, consideration should also be given to several other questions: How easily can problems be diagnosed? Where are spare parts located? How fast can the system be put back on line?

The control builder or user probably has more affect on availability than the designer, because the environment in which the computer operates helps to determine its life. The sturdiest computer on the market will not last as long at 120°F as it will at 68°F. Operation is continuous in an electrically isolated chamber as compared with operation next to a Van de Graff generator. Maintenance is much faster when spare parts are on hand.

Most minicomputers are relatively new machines and, therefore, little reliability data is available. However, certain structural considerations will increase reliability and ease of maintenance. The complexity of the computer and current trends toward high density in printed circuit board design virtually eliminate troubleshooting of components while the board is on line. However, provision for off-line testing of circuit boards and functional grouping of components can make trouble-shooting faster and easier. Redundancy is often used to assure high availability, although this approach is used less frequently on the low-cost minicomputers. Design that permits isolation of faults is a far more practical method of meeting availability requirements within the price structure of the new minis.

Documentation

Aside from the design of the machine, the most important consideration is the availability of information about the machine. The user must have sufficient information available to connect the computer to the process. The primary cost of building the interface is the engineering time involved. Without sufficient knowledge of the machine, it is impossible to build the interface. The vendor is the only source of help at this point. Therefore, it is necessary to choose a vendor who can train the personnel involved and provide documentation to aid this effort. A few vendors provide schools, books, drawings and people to aid at any level of effort from main frame cards to full system responsibility.

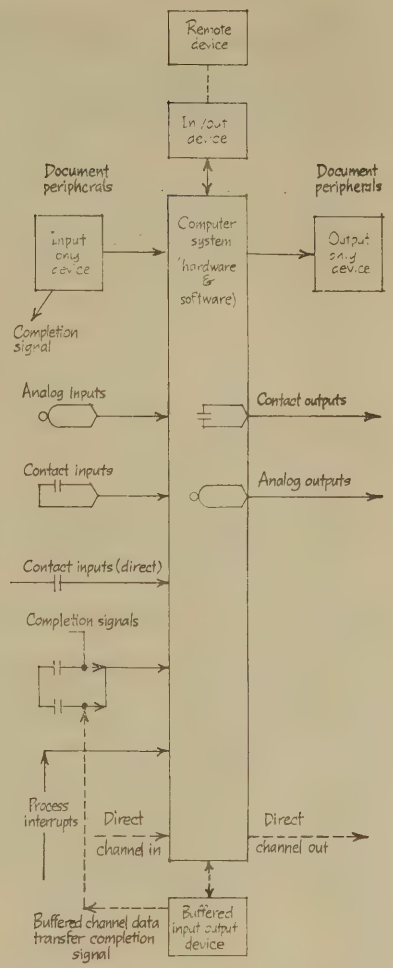


Fig. 3
Configuration of complete (hardware plus software) minicomputer system gives some idea as to what kinds of communication must be facilitated between the computer, its immediate environment, and the process.

Deflection and convergence systems for the shadow mask picture tube

by P. Cooper, B.E.(Hon.)*

Lecture given to the Wellington Branch, New Zealand Electronics Institute on 17th July, 1969.

NORMAL CONVERGENCE ERRORS

Fig. 1 below shows a plan view of a shadow-mask tube with static convergence only.

As can be seen, the static convergence causes the three beams to create a single spot at the centre of the tube but because the deflection centres do not coincide with the centre of curvature of the shadow mask, the point of convergence does not remain on the screen but describes an arc as shown. This results in the three beams producing mis-registered spots at all points on the screen other than the centre. Careful study of Fig. 1 shows that the registration errors occur in the same direction for any one particular beam regardless of the position on the screen, and also that the errors are approximately equal at four points symmetrically disposed about the centre of the screen.

The errors for simple dot-pattern signal are shown in Fig. 2 greatly exaggerated.

A careful consideration of the effect of a parabolic plus sawtooth convergence current applied separately to each

*School of Engineering, Wellington Polytechnic.

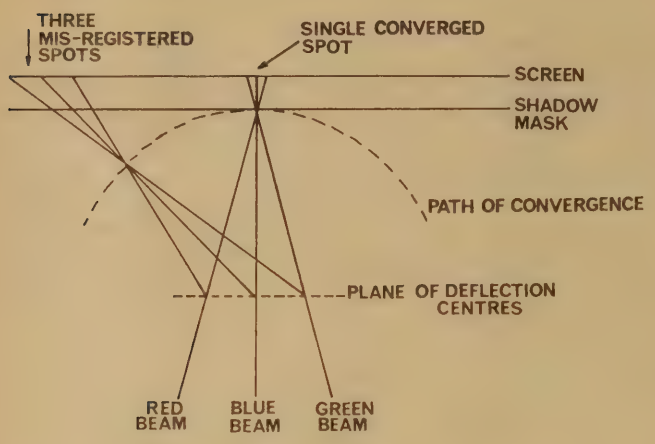


FIG. 1

beam shows that, in theory at least, a suitable combination of vertical and horizontal parabolic and sawtooth currents will make possible complete dynamic convergence.

GENERATION OF HORIZONTAL CONVERGENCE WAVEFORMS

Parabolic current waveforms at line frequency are most easily generated, in an inductive load such as is presented by a convergence coil, by applying a sawtooth waveform of voltage to the coil and allowing the natural integrating property of the coil to create the required parabolic current. This is most easily achieved by inserting a partly variable resistor in series with the horizontal deflection coils which of necessity must carry a sawtooth current waveform. The resulting voltage drop will have the required sawtooth waveform provided that the parabolic current drawn by the convergence coil is limited to a small fraction of the sawtooth current.

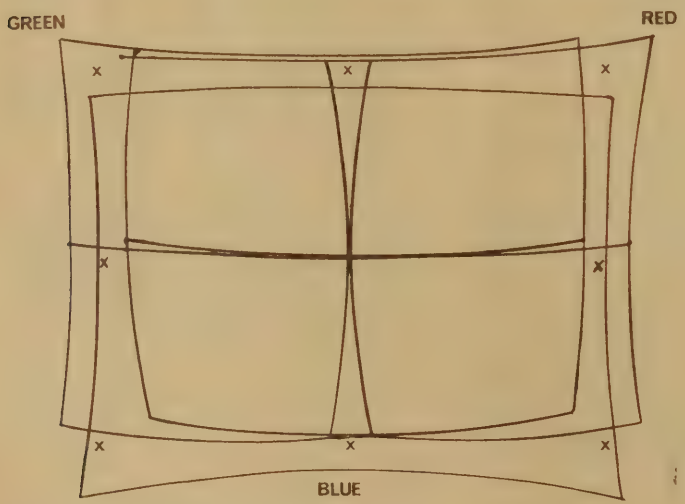


FIG. 2

From Fig. 2 it can be seen that the red and green beams require approximately the same amount of dynamic convergence correction and for this reason their correction coils are usually connected in series and controlled by a single variable resistor, any slight differences necessary being supplied by an auxiliary connection of the red/green common point to an adjustable tap on the resistor. This method of control provides a considerable advantage over individual control when ease of adjustment is considered for the following reasons:—

1. Equal movement of the red and green spots in the same direction results in only horizontal relative motion thus the combined control may be adjusted for red/green coincidence of vertical lines.
2. Equal movement in opposite directions results in only vertical relative motion thus the differential control may be adjusted for horizontal line red/green coincidence. Clearly these controls are essentially independent of one another.

The basic series resistor arrangement is usually modified as shown in Fig. 3 below to provide a tilt control, i.e. a variable sawtooth component which can be used to cause the corrections on the left and right hand sides of the screen to be different.

In the above figure the two inductors are coupled mechanically but not inductively. The inductance values are small and do not appreciably alter the waveform of the sawtooth current flowing in the two branches. Across each inductance a pulse e.m.f. arises which is equal in both sides, and thus has no effect on the convergence coils, provided that the ratios of inductance to resistance are the same in both sides of the circuit. If an inbalance is introduced, however, a net pulse e.m.f. acts in one direction or the other and causes a circulating current to flow around the loop. The resulting pulse e.m.f. across Rs causes the desired sawtooth currents to flow in the convergence coils.

Further reference to Fig. 2 shows that the blue convergence coils will require greater parabolic currents than the red and green coils. In the first instance the extra parabolic waveform is obtained by using a larger value series resistor but in order to avoid introducing too much resistance in series with the deflection coils an additional circuit is connected in parallel with the series resistor. A complete basic blue radial convergence circuit is shown in Fig. 4.

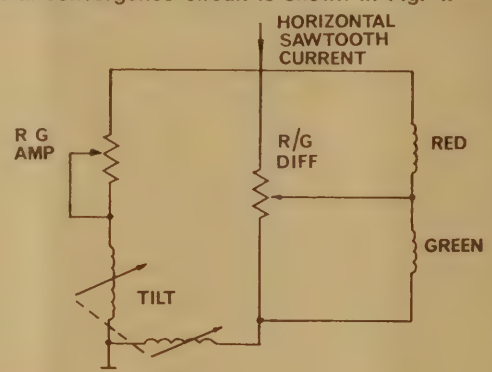


FIG. 3

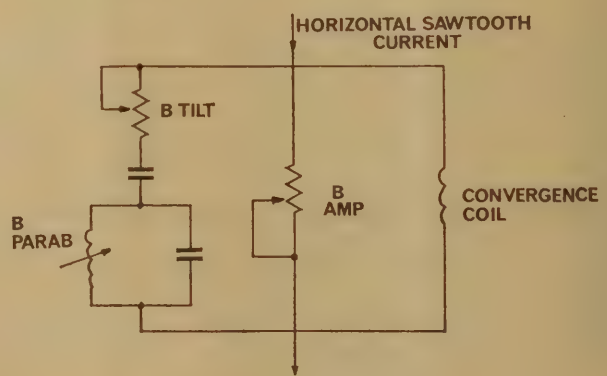


FIG. 4

The approximate sawtooth current flowing through the resonant circuit which is tuned to twice the line frequency creates a second harmonic e.m.f. across the tuned circuit and this e.m.f. opposes the sawtooth current at the beginning and end of the sawtooth and assists it in the middle. This has just the opposite effect on the current in the Rs branch, i.e. augmenting the sawtooth at the beginning and

end and diminishing it in the middle. The resulting integrated current flowing in the convergence coil is a much enlarged quasi-parabolic current which is sufficiently close to the correct waveform for there to be no detectable convergence errors. By including a capacitor in series with the resonant circuit, a parabolic e.m.f. is generated which assists the sawtooth at one end and opposes it at the other. This provides a convenient method of supplying a tilt component to the convergence coil current.

Other methods of providing the required horizontal parabolic and sawtooth currents do exist but are invariably more complicated and require more components, particularly wound components. The method described here represents probably the most economical solution which has been found to date.

GENERATION OF VERTICAL CONVERGENCE WAVEFORMS

At field frequencies the convergence coil windings can be considered essentially resistive, which means that the required sawtooth and parabolic currents are created by applying sawtooth and parabolic voltage waveforms to the windings. Unless the primary inductance of the field output transformer is very large, so that it takes a negligibly small current compared with the reflected load current, the total valve (or transistor) current will consist of the sum of the sawtooth load current and the parabolic magnetising current with the addition of the normal d.c. component of course. It is this situation, together with some integration due to imperfect bypassing of the cathode resistor, which is responsible for the familiar parabola plus sawtooth waveform which arises at the cathode of the field output stage.

This waveform is applied to two potentiometers and thence to the convergence coils which are returned to earth via further potentiometers which are fed with a sawtooth voltage waveform of opposite polarity to enable the sawtooth components of the currents to be controlled independently of the parabolic components.

The red and green controls are 'matrixed' in the same way as for the horizontal convergence, thus providing effectively vertical and horizontal adjustments. A typical arrangement is shown in Fig. 5.

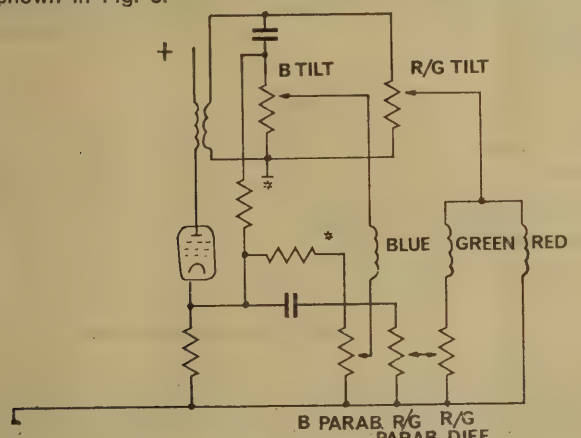


FIG. 5

The resistors marked with an asterisk are used to set the d.c. levels of the parabolic and blue sawtooth waveforms in order to eliminate the need for re-adjustment of the static convergence controls during dynamic convergence adjustments.

DYNAMIC RASTER CORRECTION

A simple electromagnetic deflection system has an inherent tendency to produce a pincushion shaped raster and this is corrected in two ways in an ordinary black and white receiver. The first is with the use of specially shaped deflection coils designed to give increased field strengths at appropriate points in the deflection field and this technique is still used in the colour receiver. Limits are set to the use of this technique, by requirements of spot size, and the addition of small permanent correcting magnets is usually found necessary to create a perfectly rectangular raster. The use of magnets is not a good solution, however, because the definition in the corners suffers and further, in a colour receiver, the colour purity is impaired in the regions where the magnets are effective.

A generally more satisfactory method of eliminating the pincushion distortion is to modify the scanning currents in an appropriate way before they are fed to the deflection coils. The required modifications are:-

(a) the horizontal scanning waveform must be modulated with an inverted parabolic waveform at field frequency.

(b) the vertical scanning waveform requires the addition of horizontal frequency parabolic components whose amplitude is greatest at top and bottom of the picture and zero at the centre.

These waveforms are shown in Fig. 6.

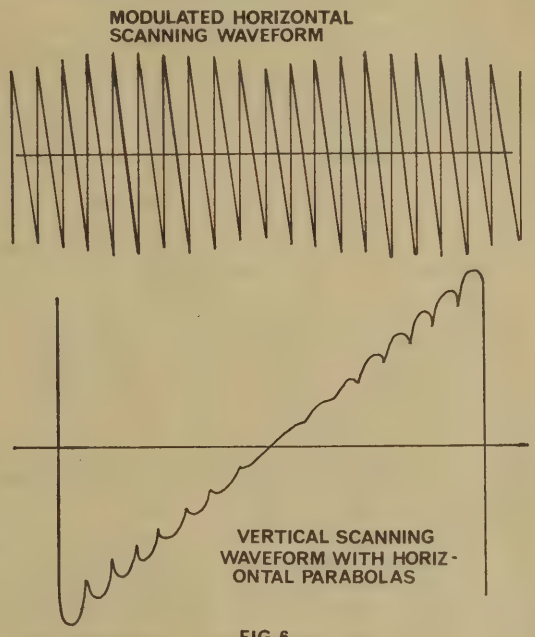


FIG.6

The above waveforms can be produced by rather complicated circuit techniques but a recent development using a saturable reactor provides an extremely simple method.

The centre limb of a saturable E-core carries a winding which is supplied with a sawtooth current at vertical frequency while the two outer limbs carry windings which are connected in parallel with the horizontal deflection coils. The outer windings are arranged in such a way that the horizontal frequency voltages which are induced in the centre winding cancel each other completely provided that the vertical frequency current in the centre winding is zero. When the centre winding current is not zero, however, the whole core is driven towards saturation and the effective inductance of the series connected outer windings falls. This has a shunting effect on the horizontal deflection coils and thus produces the required modulation of the horizontal deflection currents. The centre winding now has a small e.m.f. induced in it due to the fact that the two outer windings are acting in opposite directions and the one which is tending to reduce the total flux has a smaller reluctance to overcome. The resultant e.m.f. is applied in the vertical deflection circuit and modifies the vertcal currents in the desired way.

DATA TRANSMISSION - I

by D. J. Barnes, G. A. MacFerson & J. M. Tricker*

With the growth of computer techniques and the need to convey accurate information to and from digital computers or data handling systems, there is an increasing demand for high speed data transmission systems. These systems may use one or more of several transmission media. Common paths for data transmission are radio frequencies, coaxial cables and the common telephone network. The introduction of optical techniques for data transmission is not widely used but may well become popular in the future.

Prior to the introduction of digital computers on the large scale we have them today, data transmission was largely confined to low speeds such as message transmission by morse code, by teletype or by analogue techniques. Today analogue and digital techniques are used independently or combined to make a data transmission network. It is possible by correct choice of transmission method to obtain high data rates over great distances. For the purpose of this article digital data rates are broken down to three categories:—

(a) Low speed:— Up to 500 bits per second over almost any commonly available channel usually requiring no special line or signal conditioning.

(b) Medium speed:— From 500 bits per second to 10,000 bits per second sometimes requiring special conditioning of the channel.

(c) High speed from 10,000 bits per second to over 1,000,000 bits per second usually over hard wired or UHF types of channels.

This series of articles discusses some of the methods used in data transmission with emphasis on medium speed digital transmission, this being the most commonly used system in computer to computer links and becoming of considerable interest on the local scene.

There are two main methods of transmitting data; baseband, which is slow and requires a large bandwidth, and modulated carrier. Modulated carrier systems are used up to very high speeds and are by far the most commonly used.

In modulated carrier transmission the information to be transmitted is carried as modulation information on an audio or radio frequency carrier. Essentially three types of modulation methods can be used corresponding to the normal modes of modulation met in telecommunications, namely:—

(1) amplitude modulation
(2) frequency modulation
(3) phase modulation
(4) pulse modulation

1. AMPLITUDE MODULATION

This method of modulation is probably the most universally understood; in this case the amplitude of the carrier is varied according to the amplitude of the information to be transmitted, in simple binary modulation this amounts to on-off keying of the carrier. The four types of amplitude modulation most commonly used in data telemetry are:—

(a) double sideband
(b) single sideband
(c) single sideband — suppressed carrier
(d) vestigial sideband

To understand the difference in these modulation methods, we need to consider the spectra of carrier waves modulated by a broad band data signal. If we commence with a sinusoidal signal with frequency ω modulating a carrier of frequency ωc and phase constant zero the resulting time function is given by the well-known expression

$$E(t) = A \sin \omega ct + \frac{mA}{2} \cos [(\omega c - \omega)] - \frac{mA}{2} \cos [(\omega c + \omega)t]$$

In this expression we can see the two sideband frequencies $\omega c + \omega$ and $\omega c - \omega$ representing the upper and lower sidebands respectively, and the carrier frequency ωc. The modulation index m has a value of 1 for 100% modulation. For a modulation signal extending in frequency from ωa to ωb the resulting spectrum is as shown in figure 1.

* All with Defence Scientific Establishment, Auckland.

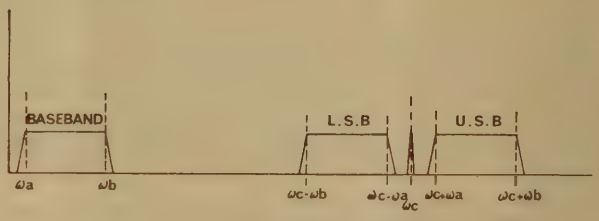


FIG.1. SPECTRUM OF AN A.M. SIGNAL

For normal A.M. using say a square law modulator other components at higher and lower frequencies can also be produced but these are usually removed by filtering and the spectrum with only two sidebands and a carrier is transmitted. The fraction of the power radiated in the sidebands is given by

$$\text{Ps.b.} = \frac{m^2}{m^2 + 2}$$

and even with a 100% modulation is only $\frac{1}{3}$ of the total radiated power. Since all the required information is carried in one of the sidebands the power efficiency of the A.M. system is low. In addition the required band width of the transmission path is equal to twice the upper frequency limit of the modulating signal, which is rather wasteful of bandwidth.

If, instead of a simple non-linear modulator, a balanced modulator is used the carrier is cancelled giving a spectrum containing the two sidebands and no carrier. Such modulators for data transmission take the form of figure 2 or alternatively one of the integrated circuit types such as the Motorola MC1596 may be used. By filtering off either the upper or lower sideband we obtain true single sideband modulation.

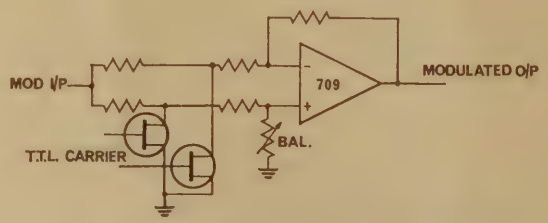


FIG 2. DOUBLE BALANCED MODULATOR

To demodulate this signal it is necessary to provide a carrier at the transmitter and receiver which are maintained stable in phase and frequency. Thus it requires at least an oven controlled crystal source at the transmitter, and a system of demodulation that is synchronous or quasi synchronous. The higher the frequency the more stable the carrier oscillator has to be. The stability of the transmitter and receiver carriers determine the final resolution of overall system.

To overcome these problems suppressed carrier systems are used in which some carrier is injected into the transmitted signal at a sufficiently low level not to require much power but such that it can be used to recover a carrier of the correct frequency and phase at the receiver. This injection of carrier can be achieved by reinserting a small amount of carrier to a post modulator stage or by slightly unbalancing the modulator.

It is not necessary to transmit a suppressed carrier to recover the carrier at the receiver end provided a small part of the upper sideband is transmitted. To understand how a carrier may be recovered we need to consider the vector diagram of the carrier and side-band components of an amplitude wave. This is shown in figure 3.

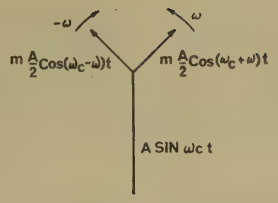


FIG.3 VECTOR DIAG. OF AN A.M. WAVE

If the carrier vector is held stationary the sideband components appear as two counter rotating vectors which combine to form a vector in phase with the carrier but varying in amplitude from + mA to — mA. If the carrier is removed we still have two counter rotating vectors and provided symmetrical components are used the resultant of these two components is a vector in phase or 180° out of phase with the original carrier. In practice complementary filters at the transmitter and receiver are used to obtain overall amplitude symmetry and phase assymmetry, creating at the carrier recovery point the required addition of the two vectors.

2. FREQUENCY MODULATION

Amplitude modulation systems are sensitive to variations in the gain of the transmission system and poor signal-to-noise ratio at the receiver. To overcome these effects particularly when radio frequency paths are used frequency modulation is preferable. In this case the frequency deviation of the signal from the undeviated carrier frequency is proportional to the amplitude of the modulating signal, i.e.

$$E(t) = A \sin (\omega ct + \beta \sin \omega t)$$

where β is the modulation index, the ratio of peak carrier frequency deviation to the modulating frequency. This expression can be expanded in terms of Bessel functions and demonstrates that even for a simple sinusoidal modulation an unlimited number of frequencies on both sides of the carrier are present spaced at multiples of the modulating frequency as shown in figure 4.

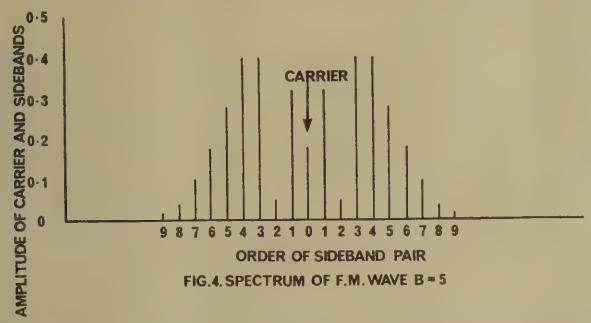


FIG.4. SPECTRUM OF F.M. WAVE B = 5

The ratio of frequency deviation to modulation frequency is a useful term known as Deviation Ratio. For low values of β the first order sideband frequencies approach those for amplitude modulation but there is a 90° phase difference between the carrier and the sideband frequencies as indicated in figure 5.

FIG.5 VECTOR DIAGRAM FOR ANGLE MODULATED WAVE OF LOW B

For modulation by more complex waves, as well as components which would be expected from each modulation component acting separately, all possible cross modulation frequencies are produced. Thus although an F.M. signal is relatively insensitive to signal amplitude variations and interference, in practice, it requires a high bandwidth if fidelity is to be preserved. With a typical telephone line channel this will limit the modulation frequency to about 600Hz, and as shown later in this series of articles this imposes a limit of about 1200 bits per sec. for this method of transmission.

3. PHASE MODULATION

For phase modulation the phase of the carrier is varied in proportion to the modulating signal and in fact can be considered as a special case of frequency modulation with low deviation ratio. Thus from the discussion above it can be seen that the properties of phase modulated signals are similar to amplitude modulated signals. If the phase shift is restricted to the range $\pm\pi$ the resultant wave can be considered as the sum of two amplitude modulated waves with carriers in quadrature. The spectra is thus that of the superposition of two A.M. spectra.

4. PULSE MODULATION

There are a number of pulse modulation methods which have been used in aero-space telemetry and other similar situations. They are primarily used for data transmission of analogue quantities and multilevel digital information and include the following methods:—

(a) pulse amplitude modulation (PAM)
(b) pulse duration modulation (PDM)
or pulse width modulation (PWM)
(c) pulse position modulation (PPM)
(d) pulse code modulation (PCM)

In addition to these four methods, there are two methods used to transmit binary signals only:—

(e) On/off amplitude modulation
(f) Frequency shift keying

Pulse amplitude modulation is a special case of amplitude modulation where the modulation waveform is sampled at discreet intervals and the amplitude of the samples which are proportional to the amplitude of the modulating signal are transmitted on a carrier. The signal looks something like that of figure 6a and lends itself to time division multiplexing of modulating signals on a single carrier.

Pulse duration modulation as shown in figure 6b can be generated by using an analogue comparator with one input connected to the modulating signal and its other input connected to a sawtooth waveform source. This relatively simple method of pulse modulation is easy to generate and relatively easy to detect.

Pulse position modulation is also relatively easy to generate and with this method the amplitude of the signal is represented by the pulse position with respect to a zero input signal position as shown in figure 6c.

Perhaps the most accurate method of transmission of analogue signals by pulse modulation methods is pulse code modulation. In this case the amplitude of the modulating signal is sampled and coded into a binary number representing the level of the signal at the sample point as shown in figure 6d. This coded number is transmitted in serial form on a carrier over the channel.

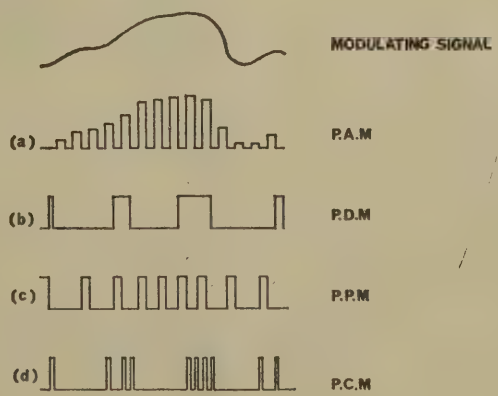


FIG.6 PULSE MODULATION

In the case of the on/off modulation the carrier is turned on by the presence of a '1' in the binary modulating signal and off by an '0'. This method of pulse modulation has little use today. Perhaps one of the earliest successful methods of low speed data transmission is frequency shift keying. It was designed to avoid the problems encountered in turning on and off a carrier in a high power transmitted particularly in the h.f. region of the spectrum. In this method two separate frequencies are transmitted to represent the binary states 0 and 1; the amount of frequency difference or shift is anything from a few cycles to a few hundred cycles depending on the use this method is put to. It is commonly found in use right through the electromagnetic spectrum to the UHF range.

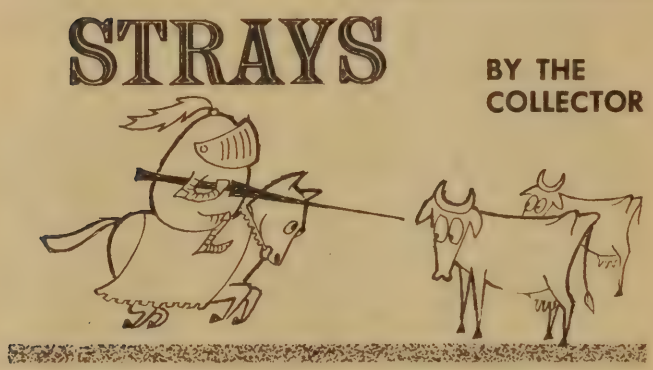
New Award Rates for Electronics Industry

Negotiations between the representatives of the radio and television industry and the Electrical Trades Industrial Union of Workers, N.Z., have been amended. This follows the movement in wages subsequent to the award which took effect on December 15, 1969, and which was to have run until June 15, 1971.

The following rates were back-dated to Monday, May 25:

(Rate per week)

	Old award rate	New amended award	Effective increase
Designer Radio Technician	$46.50	$60.11	$13.61
Foreman	$42.47	$55.00	$12.53
Registered Radio Serviceman	$40.96	$53.04	$12.08
Technician	$42.47	$55.00	$12.53
Radio Tester	$39.68	$51.38	$11.70
Improver	$38.75	$44.68	$5.93
Installer	$36.79	$42.40	$5.61
Checker	$36.79	$42.40	$5.61
Assembler	$35.75	$41.23	$5.48
Adult female Assembler	$34.70	$40.00	$5.30
	$25.40	$30.00	$4.60



"The Committee recognises that noise, although not material pollutant, could be regarded as one of the most offensive of current air pollutants."

"Air Pollution", the report of the Air Pollution Committee of the N.Z. Health Dept. (August, 1970).

It caused some surprise that the Health Department's Committee on air pollution suggusted that noise is also a pollutant, along with smoke and other chemicals discharged into the atmosphere. Perhaps the Committee might have gone even further, and talked about the pollution of the ionosphere by radio interference?

The New Zealand Electronics Institute has brought to the attention of the Marine Inquiry the pollution on the 2 MHz distress frequency by Japanese and Russian fishing boats working on that frequency in these waters, and has asked for more effective control. However, the pollution of the shortwave band by interference is old hat to all radio-telephone people. Beginning after about three o'clock any afternoon, those Aussies and Yanks begin to pour in, and swamp out all except very limited ranges on these bands.

The N.Z.B.C. receiving site at Quartz Hill can tell a tale of the multiple uses of frequencies by the shortwave broadcasters all around the world, several stations occupying each frequency and clamouring to have their propaganda or views foisted on to the listener. However, the increase in local broadcasting stations around the world is taking the listeners away from shortwave, so there is always the hope that this form of ionospheric pollution may decrease. Except insofar that shortwave stations rank almost with an airline as the status symbol for every emerging country, which has to prove it is "free" to all the world.

Talk of local broadcasting, however! Private stations coming into the medium wave band in New Zealand are adding to the interference/pollution problem, already a drastic one in Europe and the U.S.A. Remember those 1 kilowatt stations set up by the (then) N.Z.B.S. in 1949 to serve districts away from the main centres? The B.B.C., the "Economist" reports, conducted an exercised which shows that the service radius of a medium frequency, 2 kilowatt AM transmitter falls to an average of one mile at nightime.

Further pollution of the ionosphere can be laid at the doors of those creatures, the C-Ber's. Those who were inclined to protest at the N.Z. Post Office, when it opened the 27MHz CB band, for restricting power to fleapower (instead of the U.S.A. limit) can now thank their lucky stars for this provision. The C-Bers, who if they are really as interested in radio communications as they say they are, could easily sit for ham tickets and play all day on ham bands, instead of polluting a band which could be very useful to industry.

Many weird effects of ionosphere pollution are being reported from that home of technology, the United States. Garage doors which mysteriously open in the dead of night, the jetliner bound for Miami where the navigational equipment indicates a course for Cuba. The U.S.A. Internal Revenue's computer whose memory went blank (the computer centre had been built in the flight path to New Orleans Airport, and radar signals erased the stored magnetic signals).

That popular marvel of medical electronics, the heart pacemaker, can fall a victim to electronics pollution. Microwave ovens have been known to throw them off their beat.

A Canadian motorcyclist with an electrically operated prosthetic arm crashed his bike when he rode under some high-tension lines. The magnetic field made the arm's motor operate so erractically that the motorcyclist lost his grip on the handlebar, and was nearlly killed.

Interference from pirates has always been with us: notwithstanding the curious legislation which allowed Hauraki to continue its unlicensed transmissions until it had put its application to the Broadcasting Authority. No doubt, however pirates on amatur bands and on radio-telephone will continue - and until all r/t users get the habit of using their callsigns, and so making identification certain.

Regenerative receivers of experimenters have largely been lost in the affluent society. No longer does a keen lad graduate from a crystal set to a one-valve receiver which whistles on every station as it was tuned in. (How many took the time to back off the control until it "plopped" just below the threshold of oscillation, before tuning in the station?) Instead, today's yougsters cut their teeth on mutli-transistor superhetrodynes and in any case will be just stringing two or three i.c.s. together in a few years' time.

Diathermy, x-rays, welders, motors, switches, ignition systems and mercury vapour rectifiers; they all add up the pollution of our ionosphere. Even the Russians are complaining about interference by illegal, amateur radio operators: "hooligans" who fill the air with "garbage."

Lasers have a much more common complaint. In exper-

iments with these for communications in Japan, Tokyo's infamous smog severely interfered with, and restricted the range of, these latest comers into the feild of communications in the radio spectrum.

While so far the discussion has concerned ionospheric propagated pollution, there is another from which is coming increasingly to our notice. These are the things which come by way of the a.c. power mains: things that go click and bang, while transformers interrupt their steady buzz and television screens flutter. This, however, is another subject.

If pollution is the "in" thing, we have it in electronics. As electronics has proliferated, so has electronic pollution. One way to deal with pollution is to regard it as waste: then there is a profit in eliminating it.

More rigid specifications; more economical use of power? Tighter bandwidth, more rationalistion of the frequtncy spectrum?

Whatever the solution is, it will not be an easy one.

PROFILES

Mr R. F. SHENNAN

Recently returned from a year's study trip visiting Australia, Europe, the United Kingdom and the U.S.A., Mr R. F. Shennan of A.W.A., Wellington, outlined his trip and discussed his impressions with "Radio, Electronics & Communications."

"I am quite happy to be back," he said. "The quantity of business is fractional compared with activity overseas, but there is a ready challenge here, despite the frustrations of delivery delays."

Mr Shennan's first stop was in Sydney where he spent time with A.W.A., working in the semiconductor laboratory and covering aspects of semiconductor and integrated circuit design and application. A.W.V. is designing and producing integrated circuits commercially to meet the rapidly growing demand of local industry. Valves are still manufactured in large quantities, Mr Shennan observed, mainly for television receiver replacement, however, there is an increasing number of television receivers on the market which are fully solid state.

After covering other aspects of A.W.A.'s operations in Australia Mr Shennan travelled through Italy, seeing various companies, and on to Telefunken at Ulm where he studied colour picture tube manufacture. At Heilbronn, also in Germany, four months were spent with Telefunken, working in the semiconductor applications laboratories for audio, radio frequency and opto-electronic devices. He also spent time with the metal oxide semiconductor design group. One of the less serious projects Mr Shennan was employed on was to develop a mechanical, light-seeking mouse which was a feature item in the firm's display at the Hanover Fair.

After some extensive travel in Europe and Scandinavia he went on to spend three months with the English Electric Valve Co. in the United Kingdom, covering aspects of image tubes including image orthicons, isocons, vidicons, and ledicons, as well as high power valves for transmitters and RF industrial heating applications. He also visited different E.E.V. plants in England and spent time covering microwave devices together with ignitrons and gas filled tubes.

Marconi Instruments, another member of the group impressed Mr Shennan with its close liaison with the industry. The obvious trend is to send instrument designers into the field to study users' problems and maintenance requirements. This attention to the users' considerations is extended to frequent meetings among sales staff so that designs are continually being developed to suit field applications better.

Mr Shennan visited the Paris Exposition (claimed to be the largest of its type in the world), the Hanover Messe, and the I.E.A. Show in the United Kingdom before continuing on to New York. Here, his time was mostly spent in R.C.A.'s design laboratories, although he had opportunities to visit most sections of R.C.A. and to gain a fair insight into the scope of the firm's activities.

"I tried to look at industry as broadly as possible," he remarked. "I find the achievements of New Zealand electronics impressive, on looking back over the trip, but we cannot afford to be complaisant. We'll have to keep on our toes to keep local industry viable."

Asked about overseas trends in electronics, Mr Shennan said that there is considerable emphasis on integrated circuit development for consumer electronics, and pointed out that colour television receivers are beginning to appear with four or five i.c.'s and a few transistors. Another important major application of electronics is in motorcars, not only for ignition and voltage control, but for such devices as light monitors or audible trafficator warning signals.

While he saw plenty of colour television, it was mainly in best or laboratory conditions and not in areas of marginal reception. The consciousness of Europeans to colour picture quality, and to FM broadcasting impressed Mr Shennan.

Colour should be introduced on a large scale, Mr Shennan considers. Where it has been "dribbled in" design and development of receivers, and demand for colour programmes have lagged as a result.

Germany's excellent labour relations also called for comment. "People have more buying power than ever before, and I noticed that employer/management relations are excellent."

"I found that people overseas are aware of New Zealand, and think of it as a place with wonderful scenery, and a high standard of living," Mr Shennan said when discussing other aspects of his trip. "They have heard that we have often been innovators in social experiments, and in general New Zealand seems to be held in high regard."

Mr Shennan is in the engineering products (Head Office) division of A.W.A. in Wellington, a position where he has become well known to many in electronics for his willingness to help customers with application problems. He joined A.W.A. in 1958 from college and has been with the company continually. His visit overseas was facilitated by A.W.A. through their overseas associates and the company's gain will be the up-to-date "state of the art" knowledge, which Mr Shennan will be able to apply for customers' benefit.

Mr Shennan is also well known as a past committee member and minute secretary of the Wellington Branch of the N.Z.E.I., and one of the organisers of the 1967 NELCON "Electronics for Export."

Mr W. S. Strong, B.E.(Elect.), C.Eng., M.I.E.E., M.N.Z.I.E., M.N.Z.E.I., Dip. Bus. Admin.

Recently appointed District Design and Construction Engineer, Christchurch, in the N.Z. Electricity Department, Warren Strong is well known for his interest in electronics. Born at Gisborne, educated at Greymouth (third form, Greymouth High School) and Christchurch Boys' High, Mr Strong joined the present N.Z.E.D. at Christchurch in 1949. On graduating B.E.(Elect.) from the Canterbury University National School of Engineering in 1954, he transferred to the Napier office of the department. Coming to Wellington as an engineer within the department in 1959, he has since risen to senior engineer within the transmission lines section. (One of his more interesting assignments in this section was the design of the Bluff - Manapouri transmission line, which crosses the rugged fiordland mountains).

Mr Strong has taken a considerable part in N.Z. Electronics Institute activities in the time he has been in Wellington. He had joined as a student in 1954, having taken electronics along with power engineering at Canterbury. As student leader of a group under Mr B. T. Withers at Canterbury, he took part in the first television transmissions in New Zealand: "I was infected with Mr Withers' enthusiasm," Mr Strong told "Radio, Electronics and Communications."

Radio had been an interest since the age of 10 and the crystal set stage, having been prompted by his father's association with electronics. Mr S. W. S. Strong, as a student at Dunedin University, was one of Professor Jack's assistants on the night of the first broadcast

in New Zealand, from 4AB in 1921.

Mr Strong senior also participated in another New Zealand electronics "first." The late Mr Ralph Slade boarded with the Strong family, and in 1924 he made the first direct radio contact with England. This was from amateur station Z4AG, using a frequency above 100 metres, which operated from "the boys' room" in the Strong household.

Mr Strong senior became a mining engineer and geologist, but maintained his interest in radio as an amateur. He held the callsigns, Z3AE and ZL2AG. Another indication of his interest in radio was the part he played in helping form the N.Z.A.R.T.

Mr Warren Strong passed his amateur examination in 1955, and has the callsign ZL2ATE. He has also been active in the N.Z.A.R.T., on branch committees, as a council member 1962-68, and currently takes part in AREC activities.

In the N.Z.E.I., Warren was Wellington Branch secretary 1960-63, and was branch vice-chairman for a period. He has represented the N.Z.E.I. on NEDA from the time this organisation was formed in 1966, and has served on various branch and Institute sub-committees — notably representing the Institute on the committee which inaugurated the advanced trade certificate in radio (communications).

However, it is for his work in organising conferences in electronics that Warren Strong will be chiefly remembered. The first of these was "The Future in Electronics," held by the Wellington Branch in 1964. The second conference was in Wellington again, in 1965, as "The Future for Electronics." After the first conference was held at Auckland in the following year, Wellington held the fourth, "Electronics for Export," in 1967.

Warren Strong was conference convener for the first three Wellington conferences and his activities here emphasize his contribution to N.Z. Electronics. Coming after the work of the present Dominion Secretary of the Institute, Mr J. L. McKie, in establishing a sound administrative base for the N.Z.E.I., the successful introduction of these conferences — now established as an annual feature of national electronics activity conducted by the N.Z.E.I. — is regarded as the foundation of the rise of the Institute to its present position in New Zealand electronics.

Mr Strong has other interests apart from amateur radio and electronics. As a former secretary and now chairman of the Wellington branch of the Christchurch High School Old Boys, and as secretary of the Tawa-Linden Beautifying Society he also finds time to attend to a rising family. Married, he has a son ("already taking an interest in radio") and a daughter.

In his new appointment at Christchurch, Mr Strong will be responsible for the construction of all new transmission lines and substations, and alterations to existing lines, substations and power stations in Canterbury and on the West Coast. Keeping up his interest in electronics, he looks forward to continuing his participation in activities of the N.Z. Electronics Institute through membership of the Christchurch Branch.

THE PLESSEY COMPANY LIMITED APPOINTS NEW MANAGING DIRECTOR

Mr Michael Clark, Deputy Managing Director of The Plessey Company Limited, England, has been appointed Managing Director.

At 43, one of the industries youngest leaders, Mr Clark has had an extensive career in the electronics, telecommunication and aerospace industries. Throughout 20 years, in addition to his own Company duties, he has taken an active part in industry affairs. In 1966-67 he was Vice President of the Society of British Aerospace Companies and played a prominent role in the industry's deputation to the Prime Minister on the future of British aerospace. He is currently a member of the National Electronic Council anl the Conference of the Electronics Industry. He is also a companion of the Institution of Electrical Engineers and of the Institution of Electronic and Radio Engineers.

Mr Clark joined Plessey in 1950 and a year later formed the Company's original Telecommunications Division. He has been closely associated with a number of important technological developments, particularly the Plessey contribution to solid state tools, oceanographic systems, nucleuronics and circuit research. In June 1962, Mr Clark became Chairman and Managing Director of Plessey (U.K.) Limited, then the largest components complex in Europe as well as being a major supplier of electronics, radio communications and circuit equipment and systems. In 1967, he was appointed Director of the present Telecommunications Group (incorporating A. T. & E., Ericsson Telephones and Plessey Telecommunication Systems) and 2 years later, in his capacity as Deputy Managing Director of the Company, he has given responsibility for all home based operations, comprising the four product groups — Telecommunications, Electronics, Dynamics and Components.

In taking up his new post as Managing Director, he will become Chairman of the Company's Executive Board. In addition, he will direct a number of corporate staff functions including engineering, contacts, operation analysis, manufacture, marketing and business development, organisation and manpower as well as management services.

Down Memory Lane

by B. S. Furby

N.Z.B.C. Programme to Preserve Electronics Equipment

If valves are "old hat," solid state is even older; or so a visit to the collection of vintage radio equipment, at present being collected at Broadcasting House, Wellington, proves. Carefully restored where attention is necessary, the collection is being assembled to preserve the N.Z.B.C's association with electronics over the years — back to the days of "wireless."

Receivers of a bygone age are the main items in the collection, the earliest being a crystal (genuine solid state!) set made about 1916 by the late Mr Beecham of Wellington. There are two coils in this set, as it is of the tuned-primary, tuned secondary variety with switched series or parallel primary tuning. One coil slides within the other, to vary the coupling. This set was made in the days before components could be bought off the shelves at your handy corner radio shop, and even the variable capacitors ("condensers," of course, in those times) were made by Mr Beecham. The plates were cut from sheet zinc and mounted in ebonite frames. So painstaking was the workmanship that it not noticeable, at first glance, that the capacitors were not commercially manufactured.

This receiver tunes up to 1300 KHz, and covers much of the band below the present broadcasting band. When built, there were no broadcasting stations — let alone radio-telephone — and reception would have been mainly for ship telegraph traffic. The semi-conductor is a galena crystal, with cat's whisker: or "point contact," in modern parlance.

Another crystal set is a commercially made English one, a "Brownie." Encased in black plastic, it has "B.B.C." stamped in it; a relic of the early days of broadcasting in Britain. Instead of collecting annual licence fees from listeners, the B.B.C. was originally financed by royalties paid on every set in the country. There is no tuning capacitor in this model, stations being tuned by a slider which varied the coil inductance; obviously a relic before broadcasting bands became overcrowded to the point they have today!

The semi-conductor used in this set is one of the famous Red Diamond crystals. In its day, this component was a must for any keen crystal set builder, and guaranteed to pull elusive stations out of thhe "ether."

Valves and Multi-Tuning

One of the earliest valve receivers in the collection is a 1925 Grebe, an American set which cost $US135 new. For those unacquainted with early valve receivers, explanations are needed to appreciate why they had certain features.

In the twenties, valve sets were battery powered; six volt accumulators for filaments (the "A" battery); packs of torch cells made into 45 volt batteries (the "B" battery); and a small nine volt battery for grid bias (the "C" battery). Batteries being expensive, every effort was made to conserve current; volume was not controlled by reducing signal input while still running the amplifying stage at full power. In-

stead, the usual method was to put a rheostat in series with the filaments; this reduced volume by limiting emission. Filament and plate currents were thus reduced. Any distortion went unnoticed with the far from perfect headphones, horn speakers or balanced armature speakers of the time. All valves were triodes (although double-grid valves were by no means unknown), of low gain, and the one type was often used for r.f., a.f. or detection.

Because the valves had low gain and battery power needed to be conserved, transformer-coupled audio amplifying stages were used. The transformers had inherent step-up ratios to give more gain, and power was not wasted (as with r/c coupling — although again, this technique was well known). The grid-anode capacities of these triode valves were neutralised of necessity. Coils were large, and as this was before screening was introduced, the axis of each coil was at right angles to the others, or all three were inclined at an angle of 45° from the vertical. Grid leak detection (which amplifies) was always popular, and a.v.c. unknown (variable-mu, multi-element valves were needed to make this possible). Early stages in the receiver were tapped into the B battery at lower voltages to help reduce coupling between stages and add to efficiency.

Each r.f. stage and the detector were tuned separately, which is why these early receivers had two or three tuning controls (for anyone who has plotted the tracking errors in a modern, expensive communications set with ganged capacitors the idea will be seen to have some merit still!)

No a.v.c. to prevent r.f. stage overloading; transformer coupled audio stages; grid leak detection; volume controlled by reducing filament current; headphones or efficiency speakers (rather than quality transducers); despite these barriers to fidelity, these early receivers perform surprisingly well. When the gain available in a modern superhetrodyne is considered, the insistence on an aerial for these pioneers is justified.

Four 201A's

The 1925 Grebe, already introduced, had most of the features just described. To dodge the Hazeltine patent, neutralising was accomplished with bucking coils instead of capacitors. This set has two r.f. stages plus a detector and two audio stages — all using the 201A valve, except for the output (a 112A). The 201A was a robust specimen of the triode thermionic valve, with five volt filament, a gain of about 4, and would cheerfully substitute for the 80 (a rectifier with five volt filament and two plates) in a later generation of a.c. receivers. The "2" was later dropped from the type number (in company with the "2" of the 227, the 235 and others of that ilk).

The grid leak resistor in the Grebe is the only fixed resistor in this receiver, although the filament rheostats are present to represent the variable varieties of this breed.

This set features a dial light — an advanced novelty for its time — and also a belt drive to attempt to couple the three variable tuning capacitors together. To overcome tracking problems, however, the lid can be lifted and each capacitor released from the drive and individually adjusted. A "tone" color" (sic) control — the medium-frequency cutoff of a variable resistor and capacitor — catered for those devotees of "mellow" sound (too many of whom are still with us today).

Valve holders then did not have sockets which gripped the valve pins. Contact was by spring contacts against the bottom of the valve pins, and the valve base had a bayonet pin which locked into a holder in the surround which was raised above the contacts. In the Grebe, the detector valve is mounted in a sprung socket to reduce microphonics.

The B battery is tapped at 22½ and 90 volts for the earlier stages, but without an output transformer, the full 135 volts on the last stage are across the headphones (or speaker).

The speaker with the Grebe is a balanced armature type. These were early cone speakers, with a lever to the cone apex actuated by an armature inside a high impedance coil. Users were warned to observe polarity in connecting the speaker, to prevent demagnetising the permanent magnet. The speaker enclosure is a familiar one to those with long memories; a hexagonal frame, with a petit-point design of a vase of flowers worked on the cloth.

Enter Browning Drake

A famous name in radio receivers of the twenties is that of Browning Drake, and the N.Z.B.C. collection features one of these. The Browning Drakes were kitsets, and the N.Z.B.C. specimen has three O1A's and a 112A. There is only one r.f. stage in this set, and the detector stage uses regeneration to obtain sensitivity (at a price in bandwidth!) Regeneration, was, in fact, one of the recognised methods of improving selectivity. The reaction control is an inductance (the "tickler" coil), and regeneration is controlled by rotating the tickler through the axis of the coil it is coupled to. The long shaft to the reaction tuning knob will be understood by those who remember "hand capacity" effect.

This set is understood to have been assembled from the kitset in 1932. One r.f. coil is vertically mounted, and the other horizontal with its axis along the length of the set. Reduction drives used on the tuning capacitors are forerunners of the "velvet vernier" dial.

Ebonite and Copper

Receivers of this vintage were almost universally built on a base of ebonite sheet, components being bolted on. Solid copper wire was popular for interwiring, frequently uninsulated, and in some sets beautifully done in straight lines with right angles to change direction. A home-built set, made locally of parts from various sources, is another item in the N.Z.B.C. collection. There is no reduction on the three tuning dials, which are familiar 4" diameter, graduated 0-100 over 180°, and operated by raised centres with milled edges. Like the Ford cars of the same vintage, the knobs could be obtained in any colour, provided it was black. As well as the filament rheostat volume control, the output 112A in this receiver had a barretter resistor (thermistor) in the filament chain.

An Altona, representative of a type made in Auckland by Johns Ltd is included in the collection. In this receiver, the coils are mounted out of sight under the ebonite sheet chassis. Associated with this receiver is an Amplion "Petal" horn speaker. This is a balanced armature driver (some driver units were only overgrown headphones), horn, and leaves of wood making up the flare — hence the name, "Petal."

Most of these receivers were presented to the N.Z.B.C. by Mr Norman Worthington, a salesman at 1ZB who has been interested in radio and DXing. Mr W. P. Huggins, a retired member of the N.Z.B.C. engineering staff, has refurbished the sets and restored them to working order, where necessary.

Mains Power and Superhets

Mains powered receivers began to appear towards the end of the twenties, and soon receivers began to take on the form they retained until transistors — with ganged capacitors needing only one tuning dial, and superhetrodynes ousting the T.R.F. Early Philips sets at Broadcasting House show the transition stages, with a variety of shapes, sizes, and "innards" as evolution progressed.

The eclipse of the early receivers saw the end of the classic cabinet; an oblong box, usually of beautifully worked and finished wood, sometimes metal. Always with a lid on top which enabled an owner to prove status by proudly displaying the number of valves in his set. The front panel; sometimes sloping, sometimes vertical; sometime wood and sometimes black polished ebonite. (There are examples in the collection of early forms of laminated plastic).

There are two examples of a variant of early Philips mains receivers. These are three-valve models (detector, audio and rectifier), the valves all mounted close together at the other end of a steel box from the tuning control. The dial scale is observed from the top. One of these sets has "2ZM, 1180 Kc/s" pencilled on the metallised coating (which served as a shield) of a valve. This is not the present Wellington station, but the early Gisborne private broadcaster.

Green d.s.c. or d.c.c. wire abounds on the coils of a Gilfillian GN2. This is an American set, worth $US124 new in

1924. The coils wound with this wire (a nostagically familiar sight to the survivors from this era of electronics) are mounted in the 45° degree from vertical, mode, to prevent coupling.

This neutrodyne receiver is one of the best of the collection

Among others, the shape of the pre-transistor receiver is forecast by a mains-powered EKCO of 1934. Ganged tuning, mains transformer, a.c. valves, plastic cabinet; this is the superhet type which endured for the next 30 years or more.

Transmitters and Testers

Receivers are far from being the total of the N.Z.B.C. collection. Early broadcasting carbon microphones (the "telephone dial" type, and double-button S.T.C.) share shelves with the earliest R.C.A. 77 velocity, and crystal microphones with head amplifiers (as used by the N.Z.B.S. until after World War II) are present with other varieties. The advent of tape recording in the N.Z.B.S. is commemorated with a "Brush" soundmirror machine. This is one of the originals of 1947, with DC erase and paper tape.

Capacitor testers of early vintage, and other test equipment long since obsolete in N.Z.B.C. practice are retained.

A Collins outside broadcast amplifier is a reminder of the introduction of commercial broadcasting into New Zealand just before the war. The Commercial Broadcasting Service, then a completely separate department from the National Broadcasting Service, installed American Collins equipment in all its studios, and the outside broadcast amplifier as used by ZB stations (until fairly recently) was a model of good machining and metalwork, as well as portability (in its day) and appearance.

Some of this equipment was stored in the Corporation's Archives Section at Timaru. When Wellington stations staged their "Expo" two years ago, some was brought up for display. Wellington staff decided to take active steps to preserve the equipment, refurbish it, and add to the collection before too much electronics equipment was irretrievably lost.

While the collection now seems to have representative samples of early receivers, there is still much interest in acquiring more test, transmitting and studio equipment. Mr N. H. Ellison, Supervising Technician at Broadcasting House, remarks on the interest he has found with many people who are preserving vintage "wireless" receivers, which the Corporation's preservation activities have discovered.

Some equipment is held in the Dominion Museum, but too much cannot be preserved — before it is too late. The N.Z.B.C. deserves praise for its efforts to retain these links with pioneer electronics, for posterity.

THE IEE CELEBRATES ITS CENTENARY

Starting on Monday, 17 May, 1971, the Institution of Electrical Engineers of Savoy Place, London WC2 OBL will commemorate the founding of their society exactly one hundred years before, on 17 May, 1871, with a week's celebrations in London. Local centres throughout the U.K. and overseas will hold associated events during the year.

The activities of the IEE, in conformity with their Royal Charter, are on a world-wide scale. There are nearly 11,000 overseas members from many different countries, some of whom are expected to attend the centenary celebrations. Leading figures in kindred engineering societies, both within Britain and from abroad, will also be present at the events.

The IEE was founded in 1871 as the Society of Telegraph Engineers and was then chiefly concerned with telegraphy, the major electrical development of the time. As the applications of electricity grew, the Society expanded both in numbers and scope, becoming in 1880 the Society of Telegraph Engineers and Electricians and in 1888 the Institution of Electrical Engineers.

Among the highlights of centenary week are a commemorative service in Westminster Abbey, a conversazione at the Royal Festival Hall, a dinner at the House of Commons, and a banquet at the City of London Guildhall. There will be an extensive programme of lectures built around the theme "Electrical Engineering in the Service of Man," and an exhibition at the Science Museum.

The objects of the Institution are to promote the general advancement of electrical science and engineering and their applications; to facilitate the exchange of information and ideas on these subjects by means of meetings, exhibitions, conferences and publications; the establishment of libraries; and to give financial assistance for the promotion of invention and research.

The IEE holds over eight hundred evening meetings a year throughout Great Britain, about forty colloquia and a number of vacation schools. There are now over sixty thousand members of the Institution, a membership that in the past has included such eminent men as Siemens, Kelvin, Swan, Maxwell, Graham Bell, Edison, Ambrose Fleming, Parsons, Ferranti, Marconi and Appleton.

N.Z.E.I.

WELLINGTON BRANCH

Closing another successful year's activities, the Wellington Branch of the N.Z. Electronics Institute held its final meeting of the year on December 3. As is becoming customary for end-of-year meetings of the branch, the subject was a forum where members were able to demonstrate items of interest.

Mr J. D. McCormick discussed light-emitting diodes, and showed one in a circuit (controlled by a unijunction oscillator) which flashed at a steady rate. Mr H. R. Pick demonstrated electronic ignition for cars, and with a demonstration unit showed the unit producing a long spark at high simulated motor revolutions.

Mr B. G. E. Henderson showed a series of colour slides of Expo 70 in Japan, and discussed the exposition.

Mr W. S. Strong, who is transferring to Christchurch, was farewelled by the branch. Mr B. S. Furby, in making a valedictory speech to Mr Strong on behalf of members, referred to Mr Strong's services as branch secretary and vice-chairman, and the work he had done in organising early conferences in Wellington and in representing the Institute in many of its activities.

The provisional programme for the first part of 1971 is:

February: "The Emerging Technician Group in New Zealand," J. Brookie (Council of Engineering Associates). This lecture, while primarily aimed at N.Z.C.E., R.E.A. or others with Technicians' Certification Authority certificates, will be of interest to tradesmen and engineers.

March: "Environmental Control" (Pye).

April: Joint meeting with N.Z.I.E., to present applications of electronics and explain them to engineers and technicians of other disciplines.

May: Annual General Meeting.

The Wellington Branch meets (unless otherwise advised) at 7.30 p.m. on the first Thursday of every month, in the N.Z.B.C. Training Centre, 5th Floor, N.Z. Display Centre Building (entrance off Sturdee Street).

Visitors are welcome, and applications to join the Institute will be received from anyone in the electronics profession. Write to the Membership Secretary, Wellington Branch, N.Z.E.I., P.O. Box 5106, Wellington.

13th National Radio and Electronics Engineering Convention

UNIVERSITY OF MELBOURNE, MAY 24 to 28, 1971

Further information may be obtained from:
The General Secretary,
The Institution of Radio and Electronics Engineers Australia,
Box 3120, G.P.O.,
Sydney, N.S.W. 2001.

INTERNATIONAL RECTIFIER APPOINT AGENT IN NEW ZEALAND

International Rectifier announce the appointment of Arnold & Wright Limited as their Sole Agent in New Zealand. Arnold & Wright is a long-established New Zealand Electrical Trade Agency and is well-known in industrial circles.

News of the appointment was released by H. C. Walford, General Sales Manager of International Rectifier (G.B.) in conjunction with L. Arnold, Managing Director of Arnold & Wright. Both are confident of being able to offer to industry an excellent availability service, an in-depth product line and the facility of a technical application service.

International Rectifier is a manufacturer of semiconductor products, including Thyristors, High Power Logic Triacs, Silicon Diodes, Voltage Regulator Diodes, Solar Cells, High Voltage Rectifiers and Rectifier Assemblies.

Principal manufacturing facilities exist in the U.K., Italy, U.S.A., India and Japan.

RACAL WIN LARGEST EXPORT ORDER

Racal-B.B.C. Limited, the Bracknell based radio communications company, a member of the British Racal Electronics Group, has announced what is probably the largest ever overseas order for military radio telephones (manpacks).

The order, which has been placed by the Malaysian Ministry of Defence, is for more than 1,000 manpacks together with accessories and spares. The total value of this order is over $2,600,000.

The 1,000 manpacks are H.F. S.S.B. receiver transmitters for carrying on the back or fitting in a variety of military vehicles. The radio telephones ordered are 5 watt 2 channel "Squadcal" sets and 20 watts 6,000 channel synthesized "Syncal" sets. The Racal "Syncal" set has, during this year, passed "Squadcal" as the world's most successful export manpack.

Racal radio equipment has proved extremely successful in Malaysia during the last 18 months. Previously announced orders from this area included a $500,000 order for manpacks in June, 1969 and a further order valued at $1,000,000 in January, 1970.

For some years Racal have shown their confidence in their manpacks by building ahead of orders. This is unusual for military electronics equipment. This policy has been a major factor in Racal winning this latest Malaysian contract which was only signed on November 2nd, 1970, but which called for the first $1,200,000 to be shipped by 7th December, 1970.

In fact, the first $1,200,000 shipment has already been delivered to Kuala Lumpur and it is anticipated that the entire order will have been completed before Easter 1971, over 3 months before the final completion date.

Mr E. T. Harrison, Chairman and Managing Director of the Racal Group said on announcing details of the order, "No other Company in the world could have given such a delivery performance for this type of equipment and confirms Racal's world leading position in the exporting of radio manpack equipment."

The equipment will be used in East and West Malaysia.

ELECTRONIC RANDOM NUMBER GENERATOR FOR BONUS BONDS

One of the most important needs when awarding large money prizes for Government Draws is to make sure that the Bond Holders do not think they are being cheated by an unfair draw. To overcome any such suggestion the New Zealand Post Office drew up a specification and commissioned the Automation and Transmission Divisions of The Plessey Electronics Group at Poole, Dorset, England, to make a Random Number Generator.

This ingenious piece of electronic equipment generates electrical noise in random bursts and then converts it into numbers. Not only does the machine make up the numbers but a special built-in test facility checks these and makes certain that the numbers chosen do correspond to the Bonus Bond numbers sold.

Having checked out and agreed the number is valid the Plessey Random Number Generator then arranges for it to be typed out. The number generating part of the machine is exceptionally fast and creates 30 numbers per second, checks them and has a facility to store these before passing them on to the teleprinter, as and when the printer can handle them.

To assist in making certain the machine is issuing valid numbers, a visual display is incorporated so that the operator can see what is going to be printed. A further check is also made by the machine which produces special punched tape to reproduce the prize list or it may be used in a computer to check that the numbers are definitely random and not produced in any sequence.

As the Random Number Generator completes its various tests at the Plessey, Poole, plant the Designer, Mr D. Statham and his team have spent a considerable amount of time seeing if it is possible to produce selected numbers. In spite of all their efforts they have had no luck, which proves that there can be no cheating with the Bond Selection Draw.

Triac Control Systems

by W. R. EASON
A.S.T.C., A.M.I.E, (Aust.) M.I.R.E.E.*

This note describes three power control circuits using the RCA triac type 40669. The circuits are that of a light dimmer, 1000W power control unit and induction motor speed control.

CIRCUIT No. I—
Triac Controlled Light Dimmer

This unit controls the intensity of incandescent lamps by adjustment of control P1. It will reduce the lamps intensity from virtually full rating to a minimum which is determined by the components. This minimum will normally be below the power level required to obtain any visible heating of the filaments. The value of 'R' can be selected to set the minimum level if required.

CIRCUIT No. II—
1000 Watt Power Control Unit

The second unit has been designed to control the power supplied to heating type of elements, fans, power supplies and other similar type of devices. The minimum output power level can be set by the "SET LEVEL" control and then raised from this level to maximum by the "LEVEL" control. The small reduction in maximum power output inherent in this low cost control unit should be of no consequence in most applications and would represent about the last 5% of available power.

CIRCUIT No. III—
Induction Motor Speed Control

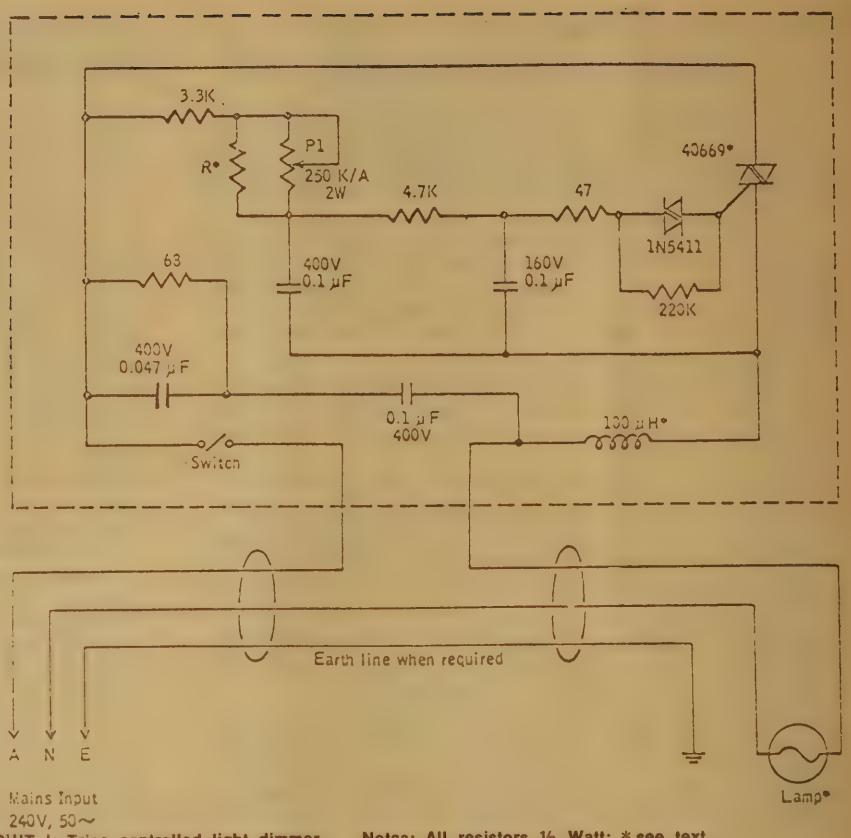
This unit has been designed specifically for induction motor speed control where speed range control from maximum to almost stop is not possible due to the motor design. The value of Rs is selected to set the minimum speed which should not be less than about one third of maximum speed.

GENERAL CONSIDERATIONS

The voltage drop across a triac is fairly constant and does not significantly increase with current until it approaches maximum rating. Consequently the dissipation of the triac is dependent mainly on operating current. For currents less than 600 mA a heat sink is not required for the 40669. If mounted on a printed circuit having about one square inch of copper under the case then the operating current can be increased to 1 amp.

When higher currents are required, then a suitable heat sink must be used. This can be an extruded aluminium sink as would be used at high current ratings or a suitable piece of 16 gauge clean aluminium. Some examples of the

*A.W.V. Applications Laboratory



CIRCUIT I: Triac controlled light dimmer. Notes: All resistors ½ Watt; * see text.

latter case are given below—

The values in parentheses are the thermal resistance in °C/W. The heat sink is given as the total surface area (both sides) in square inches of a 16 gauge piece of clean aluminium. If sandblasted and finished in mat black the total surface area can be reduced to 66% of the indicated areas.

THE SWITCHING ACTION OF THE TRIAC IN THESE TYPES OF CONTROL UNITS WILL PRODUCE VAST QUANTITIES OF R.F. INTERFERENCE. THIS WILL INCREASE WITH THE EXPANDING USE OF PHASE CONTROLLED DEVICES AND IT IS OF PARAMOUNT IMPORTANCE THAT EACH UNIT GENERATES THE MINIMUM AMOUNT OF INTERFERENCE.

It is for the above reason that RF suppression has been included in all circuits, otherwise it is virtually impossible to use a receiver of any type near the units or even on the same power supply lines. The 100 microhenry choke shown in the circuits is not critical, 20% tolerance is acceptable, but must be rated at the maximum operating current of the device and when used in conjunction with the other suppression components has an overall effective Q of about 3. This Q value provides the desired damping without any significant ringing. This choke can be manufactured as follows:—

I Lamp Circuit, Current 1 Amp. 3 layers of 22 A.W.G. enamel wire on a ⅝" former. Total turns about 110 to 120.

II Power Circuit, Current 8 Amps. 2 layers of 16 A.W.G. enamel wire on a 1 inch former. Total turns about 100 to 110.

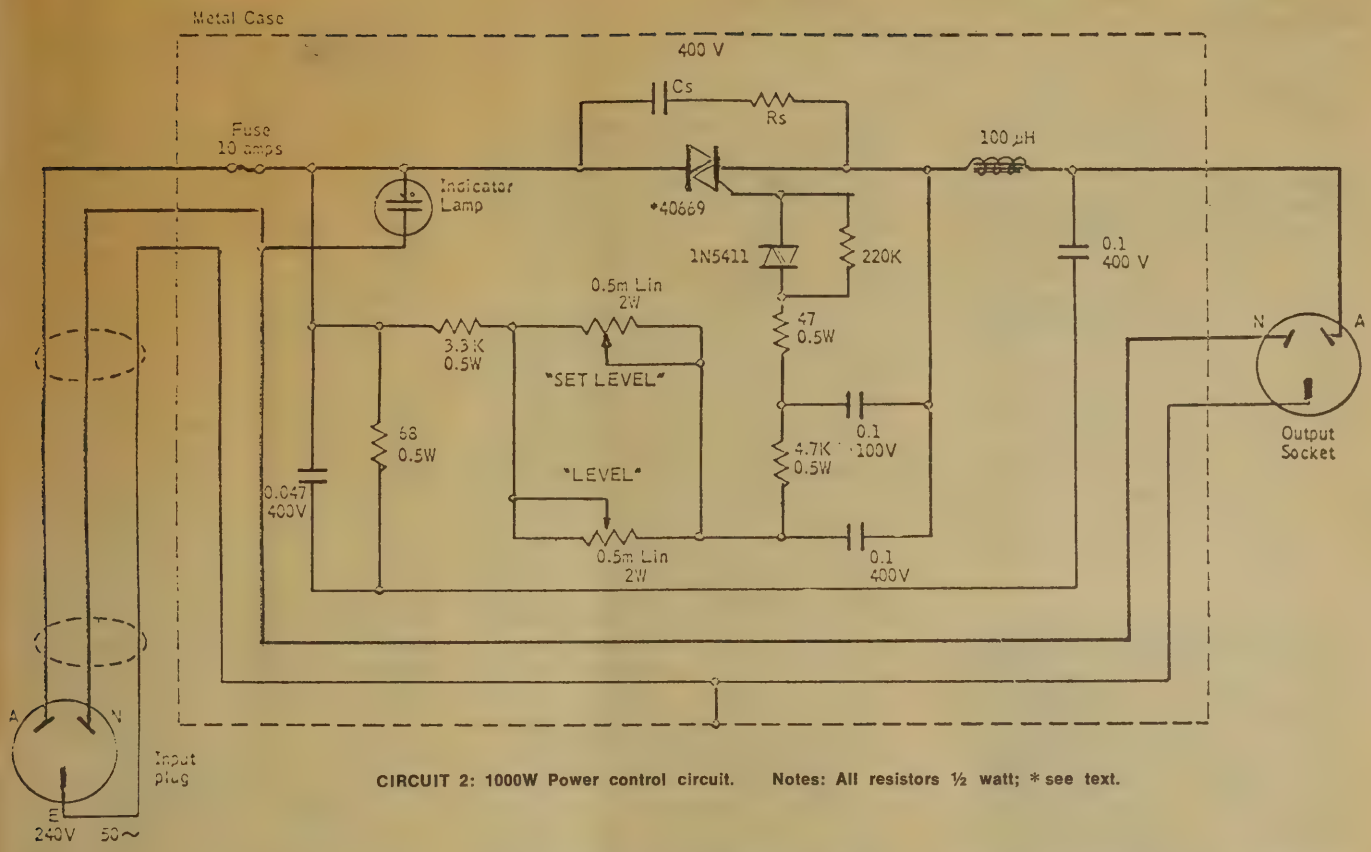
III Power Circuit, Current 4 Amps. One layer of 18 A.W.G. enamel wire on a 3 inch length of ferrite rod fitted with a tight paxolin former. Total turns about 70.

The above chokes could be used on any of the units if required so as to suit the load current.

When an inductive load is connected to the units problems may develop with

HEAT SINK SURFACE AREA

Current in Amps	Ambient Temperature in °C 45		55		65	
2	11	(23)	15	(18)	20	(13)
3	18	(14)	22	(11)	32	(8)
4	25	(10)	32	(8)	40	(6)
6	40	(6)	65	(4)	—	(2.5)
8	—	(3)	—	(2)	—	(1)



CIRCUIT 2: 1000W Power control circuit. Notes: All resistors ½ watt; * see text.

$\frac{dI}{dt}$ the rating of the triacs. A snubber network formed by Rs and Cs, in series, is placed across the triac to keep within these limits. First selecting a suitable capacity in the range of 0.047 to 0.33 microfarads for Cs, then Rs can be derived from the relationship

$$Rs = \sqrt{(L/Cs)}$$

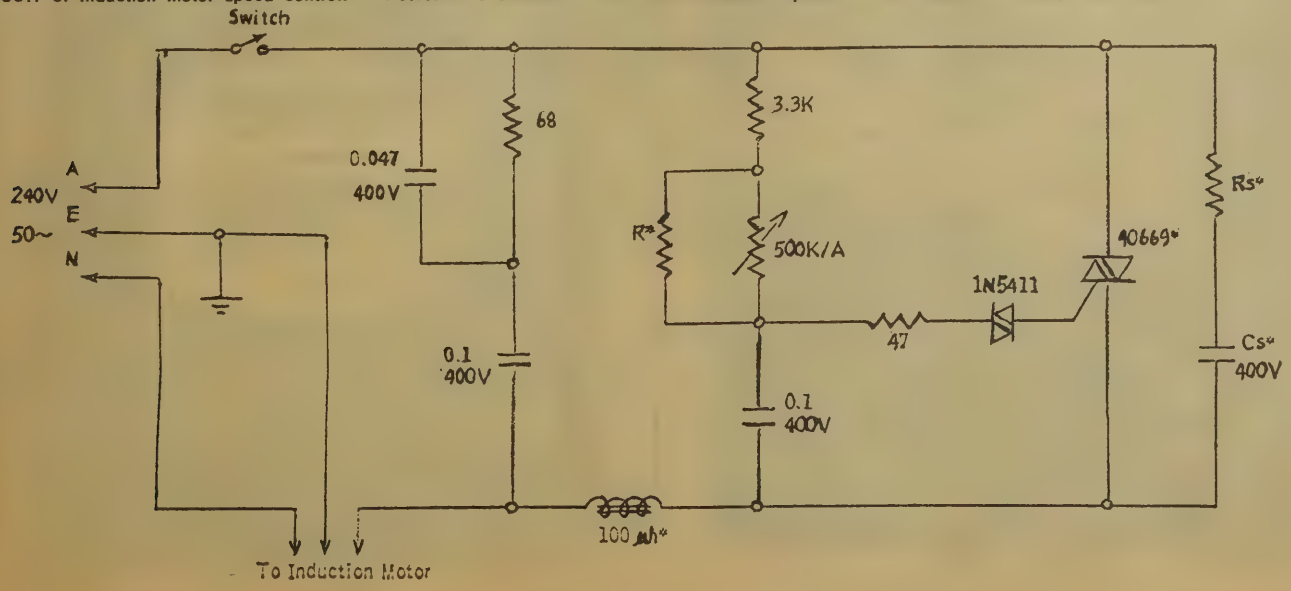
where L is the maximum value of load inductance under the worst conditions of operation. From the value of the two snubber components, the power rating of the resistive component can then be determined knowing that maximum dissipation occurs when the triac is continuously in the 'off' condition.

Although the units have been designed for the 40669 triac and 240 volts, lower voltages can be applied with small components value changes. For higher powers the triac rating is increased by using the 40576 for currents up to 15 amps without any other circuit modifications. The size of the heat sink for the 40576 triac will need to be increased to allow for the higher power and its thermal resistance can be determined from the 40576 data sheet.

CONCLUSION

When operated as intended, the above circuits will provide continuous control from the minimum to maximum design levels. Due to the simplicity of the circuits there is some loss of control at the extreme limits but this should not be of any consequence in the intended applications. These control circuits should prove very satisfactory and so enhance the range of possible application of solid state devices.

CIRCUIT 3: Induction motor speed control. Notes: R is selected to set motor minimum speed. All resistors ½ watt; * see text.

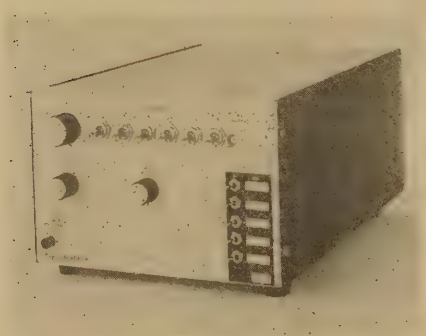


NEW PRODUCTS

SWEEP MARKER GENERATOR

These new narrow-band Sweep Marker Generators (1312 Series) are all-solid state and provide stable operation from electronically tuned and swept oscillators. The generators employ narrow, crystal-controlled pulse-type markers since the normal birdy-type markers are unusable for extremely narrow bandwidths. The 1312 Series markers are derived from unique crystal-filter circuits using inexpensive quartz crystals. The type of circuitry precludes any spurious crystal responses; no threshold or trigger-level controls are used. Thus, the markers are stable and accurate regardless of the sweeper's operational parameters.

Up to five markers may be controlled by individual front panel on-off switches and are available as positive or negative 35-volt pulses. The markers may be used for oscilloscope "Z" axis modulation (intensification or blanking), or may be added to the vertical axis as sharp, differentiated pulses. Use of an internal jumper wire allows the markers to shut off or "blank" the sweep oscillator coincidental with the marker frequency. Marker width is always approximately 1/100 of the scope display, providing a sharp, readable marker at bandwidths of 50kHz or 24MHz.



The 1312 Series also provides 79dB in steps of 3, 6, 10, 20, 20 and 20; plus either 20 or 30dB of variation attenuation, reducing its 1-volt rms output. Twenty or 30dB of this attenuation is provided by an electronic attenuator using P.I.N. diodes in a "closed-loop" leveling system. This provides a constant-source impedance and stable centre frequency regardless of the setting of the attenuator.

The 1312 Series Generators are available in the frequency range of from 4MHz to 250MHz, although the centre frequencies and maximum sweep widths are limited by the market circuits.

Enquiry No. 252

* * *

PROGRAMMABLE OSCILLATORS OFFER MANUAL AND REMOTE FREQUENCY SELECTION

Two new low-priced, all solid state, programmable oscillators with superior performance specifications normally found in more expensive sine wave generators are now available. Both units offer manual and remote automatic frequency selection and produce sine and square waves simultaneously, with sine wave output providing ½ watt power into 50 ohms at a distortion level of less than 0.02% over most of the range.

Model 4131R is a precision programmable oscillator covering the frequency calibration accuracy within ±0.1% and a frequency resettability of better than ±0.01%.

Model 4130R is a programmable oscillator covering the frequency range of 1Hz to 1MHz with a frequency calibration accuracy of ±0.1%.

Both the Model 4130R and 4131R are R-C oscillators that generate true sine waves without waveform discontinuities that tend to introduce high order harmonic distortion, problems common to synthesized or waveshaped generators. A unique AVC circuit is used to minimize transients and reduce amplitude modulation after switching, recovery time being typically 20 milliseconds. The AVC circuit provides a short term amplitude stability of ±0.002%, hum and noise of less than 0.02%. This performance coupled with a frequency response better than ±0.05db, make these instruments ideal in automatic systems requiring precision measurements. Both units offer manual and remote frequency selection.

Enquiry No. 279

* * *

IN-SITU MONITORING OF LOGIC MODULES

A new range of plug-in, digital logic modules are designed with a simple monitoring system that eliminates permanently wired lamp and switch monitors.

The modules, developed in Britain, are monitored with a self-contained unit which plugs into the front of the module and the state of the logic function is shown by lamps in the monitor unit. The monitor unit obtains all its power supplies from the module being monitored, and correct location on the printed circuit edge is ensured by a slot and key system.

The module range, available either as components or built into digital control systems, uses integrated circuits and discrete components to give optimum balance between operating speed, size, immunity to electrical noise, and cost.

As well as gates, binaries, and output drivers, the range includes a packaged reversible BCD counter module and a multiplexed numerical display driver which enables five numerical display tubes to be driven by a single module using only fifteen connections instead of the more normal 51. There is a full range of input filter modules.

All the modules use DTL logic and are designed to work at a maximum frequency of 40KHz. The logic levels are "1" level plus 6.0 volts and "0" level plus 0.9 volts, and complementary outputs are provided on all modules. The fan out of the system varies up to 20 loads depending on the type of module.

The modules are constructed on 0.055 inch thick, glass-filled, epoxy-based printed circuit board and are of single or double height configuration. The single height modules measure 6in. by 2.5in. and fit in 18-way in-line connector. The double height modules measure 6 inch by 5.375 and require two 18-way in-line connectors. The printed circuit edge connectors are gold plated.

Enquiry No. 288

"SEMIKRON" SEMICONDUCTORS

A new range of highly professional semiconductor rectifiers is becoming available to the New Zealand market. Standard Si Rectifier diodes embrace .8-320A, 400-1600 PIV, while special versions exist for Arc Welding Purposes and others have controlled avalanche characteristics. High voltage versions of the latter embrace .25-2.0A, 1300-50 KV. The Silicon Thyristor range boasts new and improved characteristics. Devices are fully diffused using high vacuum techniques, and have high resistance to thermal fatigue caused by extreme temperature cycling. Types are available from 45A-220A max. mean forward current, with peak inverse voltages from 200-1600 PIV, and junction temperatures of 130°C and 150°C. Special types have extremely short turn-off times (tq), rates of rise of voltage dV/dt up to 1000 V/uSec., and rates of rise of current di/dt up to 125 A/uSec.

Small silicon rectifier diodes and bridges also feature prominently. These range from half wave 1.0A (400, 800, 1250, 1500 PIV) to 4.0A bridge devices (400, 800, 1250 PIV).

The line has besides Silicon a very potent SELENIUM capability. These Se rectifiers withstand tropical humidity, are shock-proof, resin sealed, and available with solder terminals or pin terminals in wide variety (.40-1.00A, 30-250V RMS). Other devices of note are the "SEMI-TRANS" Selenium Transient Voltage Suppressors. These are used in converter and rectifier equipments to protect silicon rectifier diodes and thyristors against voltage transients.

Selenium Plates and Rectifier Stacks and Silicon Rectifier Stacks are also offered. The product line is completed with the availability of Plug-In solid state replacements for H.V. Rectifiers of the 816, 866A types. Appearance, finish, packaging and speed of factory delivery leaves nothing to be desired ensuring that Semikron remain leaders in their specialised and fast expanding field.

Enquiry No. 260

A NEW PULSED HIGH-CURRENT FIXTURE FOR THE TYPE 576 SEMICONDUCTOR CURVE TRACER

The measurement capabilities of Type 576 Curve Tracer has been expanded by introducing the new 176 Pulsed High-Current Fixture. The plug-in concept allows the 176 "Front Porch" configuration to fit in place of the standard test fixture. It is programmed from the 576 mainframe except for controls not provided on the mainframe. The 176 increases the Step Generator and Collector Supply ranges of the 576 by a factor of ten (to 20 A Peak and 200 A Peak respectively).

Pulsing the collector and base steps permits checking diode characteristics, and collector emitter breakdown, at currents much higher than previously possible as dissipation limits are not exceeded. The need for heat sinks is also eliminated.

The 576 features AUTO SCALE-FACTOR READOUT. Placed adjacent to the CRT are digital indicators of vertical and horizontal deflection factors, step amplitude, and Beta/div or gm/div. The 176 corrects the readout display automatically when in the X10 STEP and X10 VERT modes. Readout offers convenience for test setup and labeled waveform photography.

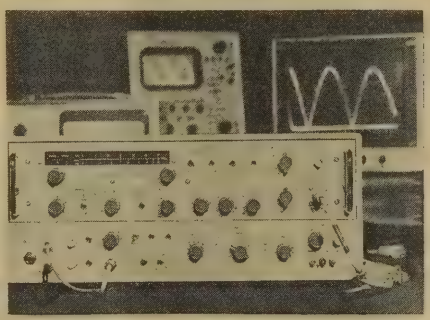
Enquiry No. 285

SWEEP GENERATOR FOR RESPONSE AND DISTORTION TESTS

A new sweep generator that provides facilities for response and distortion tests on many types of electronic circuits will be displayed for the first time.

It is called a TF 2361 and is made by Marconi Instruments. With a wide range of sweep speeds — from 0.01Hz to 100 Hz — this comprehensive measuring instrument is suitable for use with XY plotters, display units or oscilloscopes. It is illustrated below.

A unique detected system flatness of ±0.05dB over the 25kHz to 30MHz frequency range in a video version makes the equipment specially suitable for frequency response checks on receivers, amplifiers, filters and attenuators. The output flatness in frequency response checks is complemented by an unusual feature which allows alternate sweeps to have different levels.



A VHF version of this sweep generator covers the frequency range 1MHz to 300MHz, and, like its video counterpart, features extremely comprehensive marker facilities. Internal and external markers can be added to the detected output or used separately. Positive or negative pulse or birdies markers can be selected.

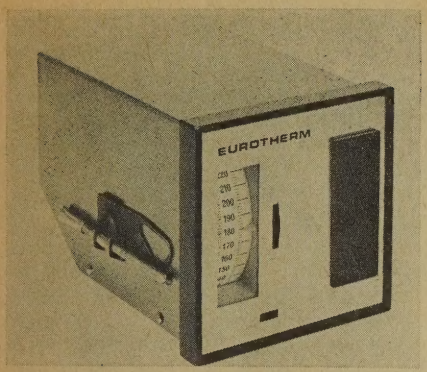
Another new Marconi exhibit will be a mobile radio test set. This instrument combines all the necessary mobile-radio servicing instruments in one unit. It includes an am/fm signal generator, a modulation meter, an absorption and thru-line power meter and an audio frequency electronic voltmeter. It is suitable for mains or battery operation.

Enquiry No. 262

SOLID STATE TEMPERATURE CONTROL EQUIPMENT

A complete range of solid state industrial temperature control equipment will be available from Eurotherm, its feature product being a new version of the Lilliput that has typical applications for diffusion furnaces, conveyor furnaces and crystal growing.

This Mark II instrument (illustrated below) is similar in appearance to the original Lilliput range, but the circuitry and board layout has been completely revised. The fascia size is only 96mm square.



There are four basic models, each available with analogue or digital setting. The sensor for detecting the load temperature can be either a thermocouple or a resistance thermometer. A variety of outputs for different applications is also available — these being slow cycling, fast cycling, phase angle, 5 volt and dual 5 volt output (for heating/ cooling applications).

The internal layout consists of a mother board mounted on the sub-frame, with additional plug-in boards. The main amplifier boards plugs into this and any of the output stages and input boards also plug-in. This results in a highly versatile arrangement which facilitates quick service.

The major feature of this new range is the extreme versatility provided by the scope of plug-in input and output options.

Enquiry No. 263

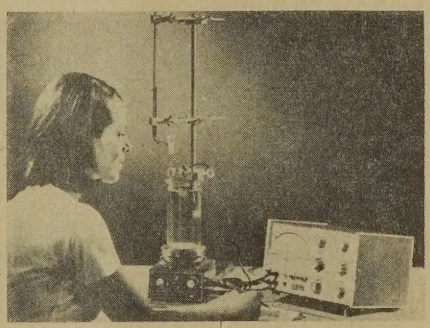
A NEW DIRECT-READING CONDUCTIVITY METER

With conventional conductivity meters, much time is spent in making calculations and changing over from one cell to another.

A new direct-reading conductivity meter, the PW 9501/01, allows rapid adjustment of cell-constant to any value from 0.01 to 30cm^{-1}. This enables results to be read out, directly from the scale, as the actual conductivity measured in Ω^{-1}cm^{-1}.

The accuracy of these results is highly dependent on temperature, so the new instrument provides full temperature compensation, from 0° to 120°C, for all ranges of conductivity. Temperature can either be monitored **automatically** by means of a 100-ohm Ni-resistance thermometer, or its measured value can be set **manually** by means of two knobs on the front panel.

During conductimetric titrations, a continuous direct reading of conductivity is available. As the titration proceeds, therefore, small variations of conductivity can be observed as well as the actual values at points of particular interest.



The two measuring frequencies have been chosen to reduce polarisation or capacity effects to negligible values. Clean, modern styling is backed up by the solid-state reliability of **full** transistorisation, which also makes for easy serviceability.

Enquiry No. 276

* * *

NEW TRANSDUCER AMPLIFIER

The Type 3A10 Transducer Amplifier plug-in unit is designed to operate in the 560-Series Oscilloscopes. The Type 3A10, when used with optional transducers, will measure mechanical quantities such as pressure, force, acceleration, vibration, displacement, strain, and temperature. Reversible "snap-in" scale factor plates permit attenuator calibration in units (Metric or English) being measured, eliminating the "mental scaling" previously necessary.

The plug-in also serves as a DC to 1 MHz, 10 μV to 10 V/div differential amplifier, similar to the previously announced Type 3A9. The upper and lower —3 dB points are switch-selectable to allow filtering of unwanted signals, which is especially useful in vibration studies.

The amplifier input resistance is switch-selectable between 1 MΩ to permit use of standard probes, and 10 MΩ, which allows direct connection of piezoelectric and other self-generating transducers. A built-in variable DC voltage

supply can be used for strain guages and other voltage-excited transducers.

Enquiry No. 284

RECORDING MILLIVOLTMETER ELECTROMETER

A recording pH meter/recording millivolt electrometer records with 21 electronically controlled speeds, from 12"/min to ½"/hour. Full scale pH spans of 1, 2, 5, 10 and 14, and any 1pH unit, 2pH units (etc·) over whole pH region of interest can be switched for full scale on 10" scale or chart recorder. There are full-scale millivolt spans of ±100, 200, 2000, 500, 1000 and 1400 with 14 calibrated 50mv increments of zero suppression which can be switched in on all millivolt spans.

Polarity reversal allows all pH and millivolt scales to be switched to provide lower values on the right or left end scale or chart. Input source resistance is capable of more than 2000 megohms. Modular design permits convenient plug-in of accessory cables or modules, and with an extra accessory the recorder module may be used independently as a 10, 25, 50, 100 and 250 mv (full scale) strip-chart servo recorder.

Enquiry No. 250

NEW pH/VOLTMETER

New economy in lab instrumentation is offered with a new pH/Voltmeter specifically designed for classroom and general work. Its research quality accuracy, high capability, straightforward, rugged design and low cost bring modern pH instrumentation to any lab or classroom. Servo-digital readout gives a meter scale equivalent length of over 44 inches. Resolution is 0.02 pH over the whole range. Parallax and reading errors are completely eliminated, and the servo-digital readout will withstand shock, vibration and user abuse. The instrument is completely solid-state, with highly stabilised power supply (zener regulated). A FET input stage provides near infinite input impedance at balance, and an isolated, shielded chopper and phase-lock amplifier give further high stability and noise immunity. Front panel controls (pushbutton operation) allow temperature and standardisation compensation from 0-100°C and exact pH readout. Multiple inputs to accomodate a range of electrodes. Output voltages equal to 10mV per pH unit are available for chart recorders, and a high impedance current source is also available for polarisation of electrodes as required for the Karl Fischer titration. The instrument is supplied on a gimbal mount, with operating instructions screened on to the mount.

Enquiry No. 249

SOLID-STATE OSCILLOSCOPE

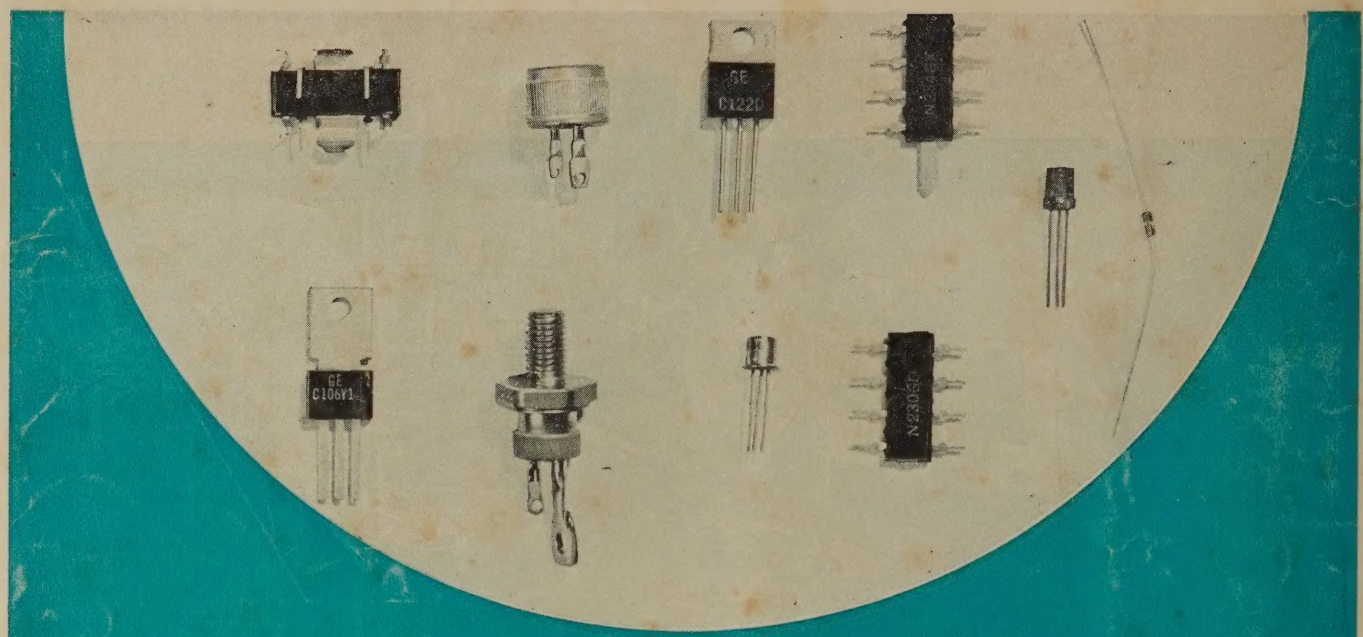
A solid-state oscilloscope, completely assembled, has been announced by a leading kitset manufacturer· Complete dual trace capability is incorporated, two separate signals being able to be displayed on the 8 x 10cm screen. The alternate and chopped modes allow both signals to appear on the screen for direct comparison. In the chop mode, both input signals are sampled at 100Khz rate so that both appear as a function of the same time base. In the Alternate mode, the two signals are alternately displayed on successive sweeps. Switch-selected AC or DC coupling enables the user to trigger the time base at a given point on the signal or at a selected DC level. Additionally, automatic triggering at the crossover point is available by flipping a switch, and triggering on either positive or negative slope is also switch selectable. (Internal, external and line trigger inputs are provided).

An 18-position time base switch in a 1, 2, 5 sequence gives a selection of convenient sweep rates from 0.5 sec/cm to 0.2 usec/cm. A separate vernier control, with a calibrated position, allows continuous control between fixed time base settings.

DC to 15Mhz bandwidth and 24 nsec rise time for each of the two identical vertical amplifiers permit analysis of high frequency and sharp front signals. The sweep gate output on rear panel delivers a +5 VDC pulse in sync with the sweep for special applications. The input impedance of the vertical channel is 1 megohm shunted by 35 pfd.

Apart from the reliability and compactness offered by solid-state, the new oscilloscope incorporates other features including easy accessibility for inspection or service, and the reduced physical dimensions and weight make the instrument handy for bench use.

Enquiry No. 248



now meet the PUT-IN-LAWS

The GE family of semiconductors

PA246 Monolithic power amplifier. 5 watts of continuous power. 16 ohm load.

PA234 Monolithic IC delivering 1 watt of continuous power 22 ohm load.

PA230 Monolithic IC. Low level amplifier with expanded operating temperature range.

PA237 Monolithic audio amplifier. 2 watts of continuous power, 16 ohm load.

ST2 Diac switch. Diffused silicon bi-directional trigger diode for the triggering of silicon controlled rectifiers.

SC141 (Triac). Silicon pellet using PNPN structure. For printed circuit or chassis mounting.

C122D (Triac). Silicon pellet using PNPN structure. For printed circuit or chassis mounting.

C106 (SCR). Silicon controlled rectifier operating directly from low signal sensors.

SC46D (Triac). 50 amp peak one-cycle surge rating.

C35D. Peak forward blocking voltage Vfom 400. Tc from —65°C to + 125°C.

DT13T1. Programmable unijunction transistor. Three terminals: Anode, anode gate and cathode.

Available from stock.
Write for detailed leaflets on any of these products or for descriptive leaflet on the whole range.

To National Electric,
282-284 Wakefield Street,
Wellington, 1.

Please send me booklet on GE Semiconductors and information on .....
.....
.....
(list products)
Name .....
Name of firm.....
Address .....
.....
.....

NATIONAL ELECTRIC

The PUT is available from stock. Enquire from your nearest branch of

THE NATIONAL ELECTRICAL & ENGINEERING CO. LTD

A member of the Cable Price Downer Group. 18 branches throughout New Zealand.

CPD

ENQUIRY A202. USE FORM AT REAR